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Commercial Opening of the Canal

OFFICIAL announcement has been made that on Aug. 15 the Panama Canal will be opened to regular traffic. Thus is verified the prediction long ago made by the chief engineer that the waterway would be opened well before Jan. 1, 1915, the tentative date fixed in the early days of the War Department's control. Repetition of the congratulations upon the virtual completion of the work is entirely unnecessary. The nation as a whole has time and again, in various ways, made known its approval of the successful handling of the great enterprise.

The War and the Union

THE entire world must suffer on account of the terrible European situation, if not directly in loss of life and property, at least in temporary financial embarrassment. American financiers, however, and the Government are fully equal to the emergency as it affects this country. The closure of the stock and produce exchanges throughout the country, the preparation to issue emergency currency under the Aldrich-Vreeland act, the placing of clearing houses on a certificate basis and the enforcement in some States of the sixty-day-notice clause for withdrawals of savings deposits will all tend to prevent the panic which, with the absence of these measures, would undoubtedly ensue. A temporary curtailment of export trade, with its stimulating effect, must be expected; but even with Great Britain in the conflict naval strategists feel that the ocean lanes will be kept open, enabling us to dispose of our farm products, with which we are now unusually well supplied. There is every reason, therefore, for citizens of the United States to remain calm. No other country is so well prepared to meet the emergency. In a short time, probably, things will assume a settled condition and business will proceed almost as briskly as though there were no unusual disturbance abroad. There is ample cause for gratification, therefore, at the favorable situation of the Union in so terrible a season.

Possibly the Union's Opportunity

SO excellent is America's economic situation at the present time that the London "Statist," the eminent financial journal, sees in a general European war a tremendous opportunity for the United States—not only to market its crops at advantageous prices, but to do a larger banking business. The United States, in the opinion of that journal, can become during the war the world's greatest market for capital. It points out that the money markets of Europe will be closed to the demands for new capital from Canada, Brazil, Argentina and other countries, and that the prestige of the United States will be immensely enhanced if it can take the place of Europe and meet the pressing needs of these borrowing countries. But these benefits can be derived only if American investors have confidence in the future of their own country, and, despite the war, in the continued progress of the entire world. The "Statist" closes with these significant words: "Should the American people take advantage of the golden opportunity afforded them by the outbreak of war, it will mean not diminished but increased prosperity for the United States." Whatever financial disturbances exist at the present minute are, undoubtedly, temporary, and though the war cannot but be disastrous abroad, there is little doubt that America will not be a heavy loser.

Cranes and Telphers

ATTENTION is called to the article on page 168 on the operation of the Kansas City municipal wharf. While this plant is not elaborate, much thought was evidently given in order to make the best use of the $75,000 available, and especially to provide mechanical means for quick and efficient handling of freight. The result was a locomotive crane on the wharf and a telpher system in the building. For the crane the designer has nothing but praise, and its adaptability to the conditions is readily seen. The telpher system, he admits, would be omitted in a redesign, as hand trucks would be relied upon to supplement the work of the crane. While the telpher system is of unquestioned value at certain plants where shipments of uniform size and weight are handled under fixed conditions, the Kansas City installation adds to its failures to prove its serviceability in moving the miscellaneous packages of an ordinary freight terminal.

Protection for Gantry Travelers

THE report on page 151 of an expensive accident, which well might have been attended with fatalities, calls attention to the frequency of similar occurrences, in which outside gantry travelers have run away, or been capsized, or both, by violent winds. It is evident that the large amount of surface exposed to wind pressure and the relatively small moment of stability possessed by the gantry are liable to be overlooked or underrated, and that serious danger to life and property is involved thereby. The obvious and usual precaution is to provide for securing the trucks or wheels by clamping, braking or blocking; but such provision may be inadequate, or, if provided, may easily be omitted, as indeed was the case in one accident where, although one set of wheels was locked, the rail clamps provided had been discarded and the wind pressure overcame the resistance of the locked wheels only. For machines in constant use the application of clamps or chocks is so troublesome that it might be expected to be neglected, but there are available automatic locking devices designed to fix the wheels when not specifically released. If these be applied to all of the wheels supporting the gantry they should always be operative when the gantry is not intentionally moved, and probably would develop such resistance that the gantry could not run away and would be much less likely to be capsized when stationary on its tracks.

Road Congress Prospects

IF the preparations for the American Road Congress, to be held in Atlanta, Nov. 9-13, are a reliable indication, the meeting should outstrip even its successful predecessor, the Detroit congress. Already papers have been engaged, which should be of unusual value to those in attendance, while the various types of construction promise to be covered in a way not before equaled at any of the road meetings. The extent of the interest already displayed is shown by the fact that forty-seven National, State and interstate organizations have joined in the official call of the congress, thus insuring a large and representative attendance. Furthermore, a most interesting innovation will be a number of sessions for officials of State highway departments, and so great is the interest in this new phase of the activities of the congress that no less than three-fourths of the States have indicated that their officials will be present. The benefit which may spring from free discussion among men from different sections of the country, all engaged in the same kind of work and confronted with the same problems, is inestimable. Furthermore, the joint committee of the American Bar Association and the American Highway Association, which has been working on the codification of State highway laws, is making excellent progress and will have a substantial report ready for the congress. Under these circumstances it hardly need be urged upon those interested in highway work throughout the country to make early preparation to attend the congress. While this seems an early date for this suggestion, experience in the past has shown that laymen highway boards do not always appreciate the advantages to their organizations of sending their engineering and administrative officials to a congress of this sort. By placing the matter before them at an early date time is afforded for impressing upon them the educational value of attendance at a congress such as this. There is no other meeting or opportunity of such value to the highway builder as is afforded by the American Road Congress. This cannot be too strongly emphasized. The benefit primarily is to the organization and not to the individual, for the information gained conduces not so much to individual advancement as to greater efficiency in handling road problems.

Road Maintenance in Chicago

MAKING "movies" of the mayor, city engineer and street bureau officials at the start of an excursion to view maintenance methods and results was the rather novel proceeding in Chicago last week. In order to show representatives of motor clubs and vehicle associations where the $650,000 wheel tax goes and how it is expended, about 150 men, escorted by city officials, made a 50-mi. tour to points where street-repair work of various kinds was in progress, to the permanent municipal asphalt plant near the center of town, to a temporary plant in the outskirts and over newly repaired streets and through routes.

Repairing streets, from the technical standpoint, is always of vital interest, and there are some excellent features in the way Chicago does it; but of most importance is the fact that a comprehensive plan based on technical inspection has been laid out. The old wrangle of the wards for the lion's share of the repairs when the budget was made up was met last year, for the first time, by a definite plan and defended by the efficiency division of the Civil Service Commission. Certain principles were defined as to apportionment of funds—such, for instance, as the making of repairs on through routes continuous and the balancing of the yearly cost of patching against the interest on a new pavement. Not all of the results desired have been obtained, but the first attempt to break away from purely political control and to base kind and location of repairs where they will serve best the greatest number is worthy of emulation by many another city.

A very instructive example of the futility and danger of the non-comprehensive plan was inadvertently staged on the trip. Western Avenue, a north and south street, is destined to be a connecting link between Chicago and the Lincoln Highway at Chicago Heights. A bad bit of road in the mile of typical non-maintained rut-infested earth road near Blue Island, between a brick road at one end and an old macadam road resurfaced with 2 in. of asphaltic concrete at the other, came near causing a fatal accident when the officials' advance car passed over a motor cycle from which one of the inspector guides was thrown. Necessity for the continuity of track maintenance on through-route railroads is not questioned. While the comparison with a through-route country road is not obvious before the route is in use, it certainly is after the road is built, and regular express-truck and automobile passenger service has been established. The Chicago plan will bear watching.

Labor Law to Be Tested

INTERESTING test cases of the New York labor law with reference to public work will soon be under way. They result from deliberate violations of three clauses in the law, one clause being violated on each of three contracts, all held by the same contractor, the Public Improvement Company. In the defense of the suits brought by the district attorney of Bronx County the contractor will have the backing of the General Contractors' Association, composed of large firms doing construction work in New York State and the East, principally on public improvements. The first clause violated is that which prohibits the employment of men more than 8 hr. in any one calendar day; the second, that requiring that only citizens be employed, and third, that requiring that the prevailing rate of wages be paid. While each of the contracts is insignificant in size and value, the violations present the same questions that arise on million-dollar jobs.

In view of the approval by the U. S. Supreme Court of the 8-hr. laws passed by the Federal Congress and by State Legislatures one would rather expect the test case on this particular clause to be decided in favor of the State. However, there is one very obnoxious feature in the New York law, which certainly needs amendment and which may be invalidated by one of the higher courts. This feature allows anyone to enter a complaint against the contractor for violation of the law, and automatically all payments on the contract are stopped until an investigation of the charge has been completed. This frequently introduces a most serious situation, for, in addition to the expense of employing counsel, the minimum time in which these proceedings can be concluded is about six weeks. In many cases, therefore, contractors are obliged to borrow money to continue the work in order to replace their withheld payments. If the law were so framed that reasonable evidence of violation would have to be adduced before the charge could be filed the contractors would not be likely to object, but now anyone having a grudge against the contractor or desiring to blackmail him can anonymously enter complaint. These are just as effective in tying up payments as bona-fide affidavits. Moreover, these things are not unknown in the history of contracting work in New York State.

As to the other cases, involving the employment of aliens and the payment of the prevailing rate of wages, one can only await the decision of the courts. It is easy to cite arguments against these clauses. They are not only annoyances but very considerably increase the cost of work. The latter phase, of course, does not concern the contractor, in his capacity as a contractor, but is of vital interest to the public at large. Compliance with the clause as to the employment of citizens on common laborers' work is becoming more and more difficult, since the citizen labor of this class is notably inefficient and difficult to obtain. Moreover, the clause requiring the prevailing rate to be paid brings up unending trouble because of the difficulty of determining what the prevailing rate is.

Because these violations have been deliberate in order to afford test cases, and since they involve issues of very great importance to contractors throughout the country, the progress and ultimate decision of the cases will be watched closely by engineers and contractors. Doubtless the sympathies of most people will be with those whom the district attorney is suing.

Prevention of Sewer Explosions

THE sewer explosion in Pittsburgh in the very same conduit which was damaged to the extent of more than $200,000 on Nov. 25 last serves to direct attention again to a subject relatively new, but nevertheless of long enough standing to be covered by stringent ordinances in more than one city in the United States. Fortunately the explosion of July 28 at Pittsburgh did very little damage.

It seems to be quite well established that most of the recent explosions are due to gasoline vapor, the discharge from both public and private garages being very largely blamed. However, reports of explosions attributed to illuminating gas accumulating both in sewers and cable conduits are not infrequent. The baffling point in practically all cases is the cause of ignition.

Whatever the cause of ignition, the one undeniable fact is that the increase in the use of power-propelled vehicles has been accompanied by an increase in the number of sewer explosions. In New York City there were a number of explosions some years ago, which resulted in the passage of stringent ordinances forbidding the discharge of any inflammable liquids or gases into the sewers and requiring all garages to install oil separators, traps or other similar apparatus for preventing volatile inflammable oils from flowing into the sewers. As a result of these ordinances the number of explosions in recent years has been considerably reduced. The city of Washington also has a stringent ordinance against the discharge of inflammable or explosive liquids into the sewerage system.

The matter is one requiring the attention of city engineers, and while prohibitive ordinances are necessary and should be adopted without delay, there is need, also, for a study of sewer atmospheres. For that reason attention is called to the brief article on page 151, in which Mr. Kellogg, assistant city engineer of New Haven, Conn., describes an apparatus for sampling sewer air. It is quite simple and should enable the location of dangerous conditions whenever violation of the ordinance is suspected in any particular locality. It could be used advantageously, too, for determining the character, as to explosiveness, of the sewer air before workmen are allowed to enter. Without doubt some such apparatus will be used in the investigation which has been undertaken jointly by the Bureau of Mines and the city of Pittsburgh. The results of this study may throw new light on the subject.

Remarkable Electrical Experiment

IT is very well known to engineers that the resistance of a metallic conductor decreases as the temperature falls, the decrement being nearly uniform for most pure metals and going on at a rate which is practically linear through a long range of temperatures. Further, the decrement is such as to point to the entire disappearance of resistance in the metal conductor at a point at or very near the zero temperature on the absolute scale, i.e., —273 deg. Cent. In fact, on various theoretical grounds, as well as from observed data, the practical disappearance of resistance if the necessary low temperature could be reached has been well understood to be a highly probable fact. It has remained for Professor Onnes, of Leyden, to push the temperatures of conductors actually down to the point at which the resistance is practically abolished. He has heretofore found that at a few degrees above zero of the absolute scale the resistances of many pure metals drop to the vanishing point. Just what this really means physically it is quite impossible to say with certainty, but it is evident that in the existence of such a condition the degradation of energy once introduced into the conductor must be very slow, so that, assuming the current were flowing through a loop of no resistance, there would be nothing in particular to check its circulation. This experiment is what Professor Onnes has recently tried with most sensational results.

He cooled a closed coil of lead wire, having a resistance at ordinary temperatures of 734 ohms and containing 1000 turns, in a bath of liquid helium down to a temperature slightly below 2 deg. on the absolute scale. The coil was in a powerful magnetic field and when this was cut off, thereby inducing a current in the coil, that current instead of being frittered away by resistance kept on flowing practically undiminished for an hour, and a measurement of the decrement in current by means of a magnetometer showed that it amounted to less than 1 per cent per hour. The current was 0.6 amp. in amount, so that the magnetizing force of the coil was 600 amp. turns, a quantity quite easy to measure with reasonable precision. The current instantly stopped when the temperature rose to 6 deg. on the absolute scale, which is the vanishing point for the resistance of lead.

Here one has a most extraordinary demonstration of the persistent flow of energy in the absence of anything which tends to dissipate it. It is as if the structure of matter at this very low temperature reached so quiescent a stage that energy once set flowing in it circulates unobstructed and without waste. It acts like a frictionless fluid in a frictionless pipe.

Phenomena such as these, when the facts are marshaled in due array and properly studied, should give a clew, at least, to basic facts regarding heat energy and electric energy which now can be barely surmised. They may even throw light on the real nature of electrical flow itself.

The Rate Decision

THE railroads asked the Interstate Commerce Commission for bread, and the commission has given them a stone—that is, all of them except the roads in Central Freight Association territory. The rate increases there allowed apply only to intra-territory rates embracing the States of Illinois, Indiana, Michigan, Ohio and the corners of Pennsylvania and New York west of the Alleghanies. None of the roads east of Buffalo and Pittsburgh are allowed increases. It is estimated that such advances as the commission has approved will bring to the Central Association roads about $10,000,000.

This is the mouse that has been produced after months upon months of labor and delay. Instead of permitting the Eastern and New England lines to put up their rates on the scale that it was estimated would bring an increase of $50,000,000, or 5 per cent on the gross freight revenue of the lines in official classification territory, the commission tells these roads that while they need more money they must get it in some other way than by raising freight rates, and these are the methods suggested: The separation of freight and passenger expenses in accounting systems with the plain intimation that the passenger business should bear a larger proportion of the expense of operation; the elimination or modification of all unremunerative rates, and doing away with special services to shippers, switching, wharfage, refrigeration and the like, or the elimination of losses in connection with such services.

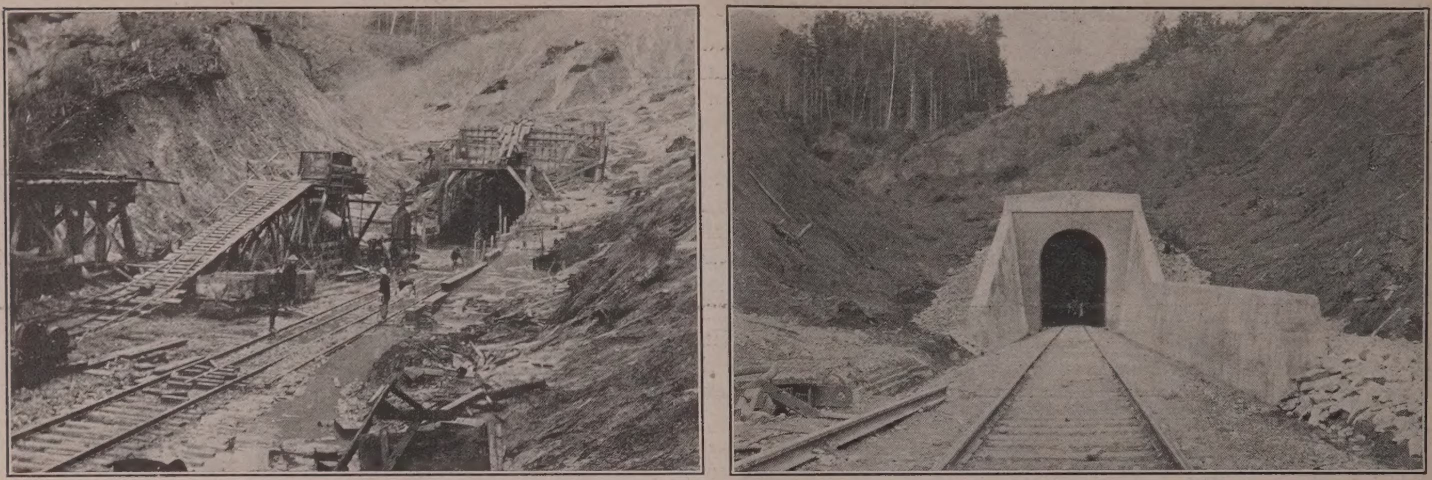
The decision of the commission may be right and just. It is backed up by very sound reasoning in many particulars. Its advice to the Eastern trunk lines is sound in many ways, but there is no doubt that the minority opinions of Commissioners Daniels and McChord more nearly represent the consensus of public opinion. Both of these dissenting opinions hold what in effect has come to be the opinion of the general public—that present revenues are not sufficient to afford a fair return upon the capital invested, and to attract such additional capital as is necessary to enable the carriers to perform their duty to the public in the fullest sense. They hold—and it appears reasonable to the lay mind—that the reasons which were persuasive as to the increase in Central Freight Association territory should have been equally persuasive as to Eastern rates.

As the majority opinion presents the matter, it is evident that it was by no means as onesided as the railroads' account of the case had led many to suppose. This appears, for example, in the commission's comment on the claim of the railroads, that they were not earning anything on recently invested capital. In regard to this the comment of the commission, that "the revenues actually received by the carriers have been earned by the whole investment, and it is not correct to say that part of the investment made since a given date has earned no return," is reasonable and a pertinent reply to the position taken by the carriers. They, on the other hand, are not faced by a theory, but by a condition, and this condition has grown steadily worse since their case before the commission was closed. Thus far this year railway revenues have decreased $79,776,279. In the same time operating expenses have increased $35,191,237, and net operating income after deducting taxes has fallen off $130,000,000, making the net income of all carriers in the United States the lowest of any year since 1907, except for the panic year of 1908. At the same time the ratio of operating expenses to revenues has gone up to 72.33 per cent, which is the highest point reached in the history of American railways. According to the commission's own figures, the average freight rates of the railways decreased from 7.59 mills per ton-mile to 7.29 mills between 1907 and 1913. This means a reduction of railway revenues of about $90,000,000.

No doubt the Eastern roads can live on the rates they are now getting; but the commission itself does not claim that they can live on the present scale or furnish the service that they have been giving. It tells the carriers—and the public might as well grasp the fact—that railway service (and this is conspicuously true of passenger service) has been on too expensive a scale. Shippers have been getting too much service for the money they pay; passengers have been enjoying too good service, and the vast terminal expense incurred by the carriers mainly for the purpose of serving the traveler as distinguished from the shipper must come to an end.

It is not unfair to say that the commission advises the railroads to conduct their business hereafter on a "cheese-paring" basis, to cut out unprofitable services and accommodations, whatever may be the prospects as to the future, and in general to be "close" and niggardly instead of enterprising and liberal in expenditures and in catering to the public. Many of the expenditures that the commission criticises as "unremunerative," and therefore to be eliminated, are those most loudly demanded by the public, and it remains to be seen whether in the long run the public will be better satisfied with methods that represent the strictest economy than they would be by the best possible service involving a little higher rate than now paid.

The railroads have not been affluent at any time in the past seven years. They are faced by the actual necessity to make long delayed improvements and replacements costing several hundred million dollars. Only such of these expenditures as cannot be avoided with safety will now be made. The result of this policy of retrenchment will be to continue "hard times," notably in the steel and iron industry and in construction work. It is, therefore, possible to admit that the commission may have done its duty in a literal sense and to applaud it for its rulings and at the same time to regret that it has taken so long to decide that the Eastern railroads should not have the money that would have enabled them to go full speed ahead.



PORTAL OF TUNNEL 3 DURING AND AFTER CONSTRUCTION, SHOWING TROUBLESOME MATERIAL ENCOUNTERED

Lining Tunnels on the Grand Trunk Pacific

Difficulties Encountered and Methods Employed in Finishing Nine Bores on the Transcontinental Line through British Columbia

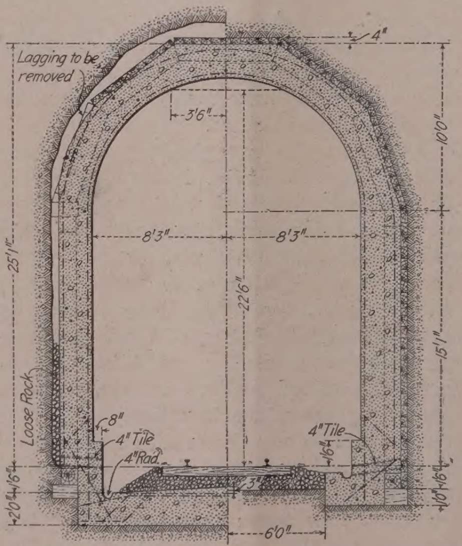
AFTER the preliminary work of driving the Grand Trunk Pacific tunnels in British Columbia had been completed "in the rough" and track laid so that construction and supply trains might pass on to the ever-advancing railhead there yet remained a difficult and expensive part of the tunnel work. This was the trimming up of the tunnels and the placing of permanent lining. On the line built eastward from Prince Rupert this work was started in September, 1912, and was not completed until February, 1914. It involved practically the same problems and difficulties that were met in driving the tunnels in the first place, with the additional factor of keeping the track clear for the passage of trains. There are eleven tunnels in this section of the road, of which two (Nos. 2 and 7) are in solid rock and required no lining. The remaining ones, which required to be lined with concrete, have a total length of about 6500 ft.

Tunnel 1, at mile 44 east of Prince Rupert, was driven for use as a snowshed during the winter months, trains using the main line, which followed the contour of the hill outside, for eight or nine months of the year. The roof of this tunnel was found to be about 4 ft. too low to allow the placing of the lining which was finally considered necessary; but since the track outside could be used for traffic while the tunnel work was under way no great construction difficulties were experienced. The downhill side of the tunnel interior was also widened down to a level about 4 ft. above the track where the rock was benched and was used as a foundation for timber and concrete. About 30 ft. of concrete lining were required in the badly broken rock at the west portal.

At mile 103.7 the main line enters a 920-ft. tunnel, about half of which is in solid rock, and required no lining. At its eastern end, however, the tunnel emerges in material which is extremely troublesome when wet. One of the accompanying views shows the condition of the portal during the work, where, after many slides, timber cribs were built to prevent the mud from flowing over the track. It was decided that long wing walls would be required at the portal, and to secure substantial support for these a pile foundation was put in and the concrete was placed under the protection of a cofferdam. Although the soft material gave much trouble during construction, once the work was completed it is said to have proved satisfactory in every way. The view of the completed portal indicates the successful operation of the subdrainage system.

CONCRETE-MIXING PLANTS

The concrete plant at this portal was arranged to be operated by two double-drum hoisting engines. One of these conveyed materials up an incline to bins over the concrete mixer, while the other handled cars loaded with concrete between the mixer and the desired point on the track. For use at this tunnel a temporary platform was fitted up on a standard flat car and provided with an incline leading up from track level. This was known as the "high car" and was moved from point to point in the tunnel, or drawn out for the passage of trains, by means of cables from the same stationary engine that operated the dump cars. When the dump cars had been charged at the mixers and conveyed to this "high car" at the point where work was in progress they were uncoupled and connected to a cable leading up the incline, operated by the engine as before. Thus the concrete was delivered at the desired point along the tunnel line on top of a platform high enough to allow it to be dumped into side wall forms or easily shoveled into the roof forms.

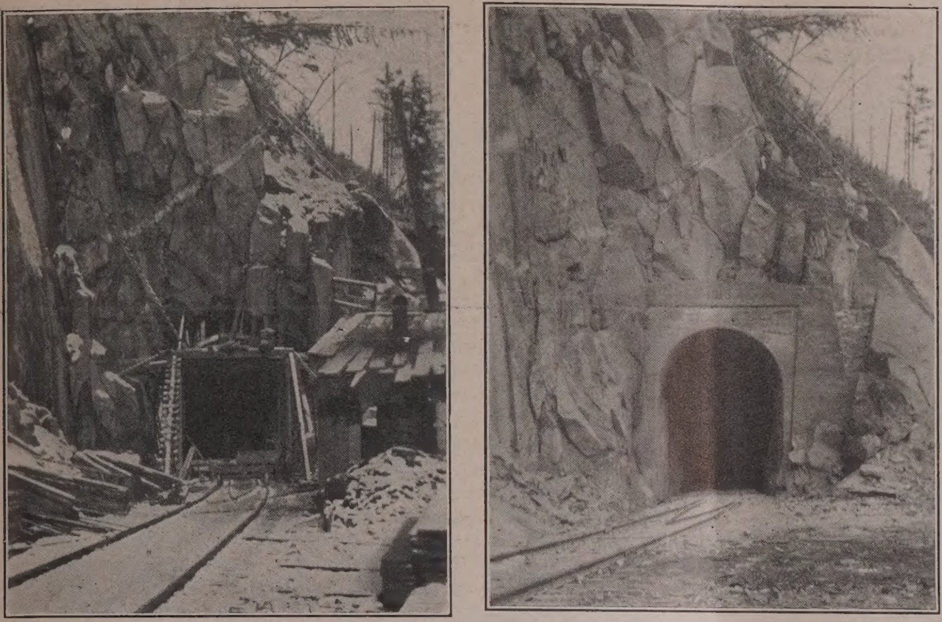


TYPICAL HALF-SECTIONS OF TUNNEL LINING

A typical plant for mixing concrete for tunnel lining is shown in the portal view of tunnel 4. This tunnel, at mile 104, is 550 ft. long, and the material traversed was so soft and broken that concrete lining was necessary throughout. Suitable space and materials for mixing concrete were found at the west portal, and the plant shown was therefore established there to supply the entire tunnel. Gravel was shoveled by hand into dump cars, shown at the left of the picture, which served as measuring boxes, each holding just enough for a batch. The cars loaded with gravel were hauled up the incline as far as the cement shed, under which they stopped long enough to receive the cement charge on top of the gravel, and were then hauled to the platform, where they were dumped into the mixer hopper as desired. The engine on the left of the track operated cars on the incline, while the one on the right hauled the concrete cars in and out of the tunnel. These cars operating in the tunnel used tracks laid on the 12 x 12-in. timber framing shown, which had to be erected throughout the length of the tunnel to support loose rock and prevent a cavein.

DIFFICULTIES IN RELINING

Perhaps the most difficult work on the line was in the 1250-ft. tunnel at mile 104.5, which had to be timbered as fast as it was driven for more than 1000 ft. of its length. All this original timber lining had to be removed to allow the final trimming up of the bore and the placing of the concrete lining. This proved to be dangerous work, because there was much loose rock behind the timbers. In this tunnel there was no alternate route, and the track had to be kept clear for the passage of trains. The method adopted was first to put in 12 x 12-in. angle braces from the side-wall posts to the tunnel floor just clear of the track. Excavation for permanent footings was then



VIEWS OF TUNNEL 1 BEFORE AND AFTER COMPLETION OF LINING

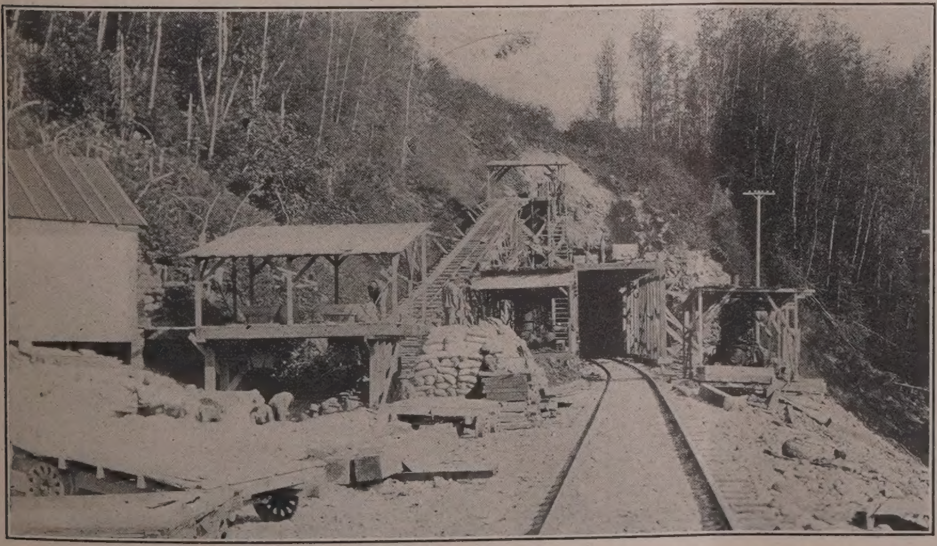
made, undermining the lower sills, while the angle braces carried the load. Concrete was then poured on foundations thus prepared and was left to harden with an offset for temporary timbering.

On the offset of the permanent footings temporary bents of 12 x 12-in. timbers were built, similar to those shown in the portal view of tunnel 4, these bents being of such size as to give sufficient clearance for trains and at the same time leave room for the lining forms. The roof timbers were then supported on these temporary bents, while original posts, sills and wall plates were removed, and the forms placed and filled up to the springing line of the arch. In some places the nature of the material was such that it was safe to remove the timbering and pour side-wall sections as long as 48 ft. at a time, while in other parts of the tunnel the ground was so heavy that 4-ft. sections were as long as could be handled with safety. After the concrete walls had set the roof timbers were removed, a section at a time. The arch was concreted by a similar process. The roof sections gave more trouble than the walls, and the lengths deemed safe without timbering varied from 3 to 32 ft.

Concrete was handled in this tunnel by the use of a "high car" similar to that already described, except that here a short incline led from the "high-car" platform to the top of the temporary bents, from which concrete was dumped into side walls or shoveled into roof forms.

The reinforcing in the concrete lining varied with the material traversed, but a typical case in gravel and clay was given a double row of $\frac{7}{8}$-in. round bars placed on 6-in. centers and extending from the footing on one side over the arch to the footing on the opposite side. The horizontal bars were $\frac{5}{8}$ in. in diameter and were placed on 5-ft. centers. Splices were required to have a 4-ft. lap and be firmly wrapped with wire. Where soil conditions required, the invert was floored with concrete, or concrete struts 4 ft. wide were placed on 12-ft. centers.

The trimming-up and lining of tunnels 1, 3, 4, 5, 6 and 8 were under the supervision of F. R. Giertsen and that of tunnels 9, 10 and 11 under the supervision of G. C. Mulville, assistant engineers, Grand Trunk Pacific Railway. Contracts for all this work were held by the Bates & Rogers Construction Company, of Chicago and Spokane, for whom R. J. Graham was superintendent.



GENERAL VIEW OF MIXING PLANT AT WEST PORTAL OF TUNNEL 4

Reclamation Service Not Planning 412-Foot Dam

F. H. Newell States That No Such Dam Is to Be Built, Although One 320 Feet High on Sun River Is a Future Possibility

IN the Engineering Record of July 25, page 112, the Pittsburgh Flood Commission replied to the criticism of that body by Sir William Willcocks (see Engineering Record of June 27, page 723, and July 4, page 16). In its reply the commission stated that the "National Government is now engaged in the construction of a dam 412 ft. in height on the Sun River, Montana." As the Engineering Record did not know of this gigantic structure, a letter was written to the U. S. Reclamation Service with a request for further information. The following reply has been received from F. H. Newell, director of the Reclamation Service:

"There is no foundation whatever for this report. It has already been brought to our attention, but we have been unable to locate its origin. The highest dam now under construction on the Sun River project is the Sun River diversion dam—height, 140 ft. Preliminary designs have been prepared for a storage dam on the Sun River, but the proposed height of this dam is only 320 ft., and as its construction is not contemplated in the immediate future none of the details of design have definitely been determined upon."

This statement having been called to the attention of the Pittsburgh Flood Commission, the following communication has been received from its engineering committee:

"Referring to the above-quoted letter from Mr. Newell, the misstatement regarding the Sun River dam was due to an error in misinterpreting a non-official engineering article of a few years ago. As soon as this was noticed we endeavored to reach you in time to change the wording to read '350 ft. in height on the Boise River, Idaho.'

"The point made by the engineers of the Pittsburgh Flood Commission is fully covered by the above reference and also the statement of Mr. Newell with regard to the proposed 320-ft. Sun River dam, namely, that very high dams are under construction and in contemplation in this country by the United States Government."

City Ordinance Gives Formula for Long Concrete Columns

THE city of Los Angeles recently passed a new building ordinance in which provision is made for reinforced-concrete columns whose length exceeds fifteen times the minimum dimension of the effective section. It is specified that such columns shall be designed for working stresses whose value shall be determined by the formula $P' = P(1.6 - L/25D)$ where P' = permissible working stress when L/D is less than 30 and greater than 15; P, permissible working stress in columns with L/D less than 15; L, unsupported length, and D, minimum dimension of effective section.

AN aggregate loss of 25½ hr. daily at eight of the eleven grade crossings of the Delaware, Lackawanna & Western Railroad at East Orange, N. J., is shown by records compiled under the direction of the city engineer. This is equivalent in time to the permanent closing of one street.

Second Explosion in Trunk Sewer, Pittsburgh

Gasoline Vapor Noted in Time to Allow Men to Escape, Thus Preventing Fatalities—Cause of Ignition Unknown

By N. S. SPRAGUE
Superintendent, Bureau of Engineering, Pittsburgh

ON July 28, at 9:10 a. m., another explosion occurred in the Thirty-third Street trunk sewer in Pittsburgh. This explosion was of less magnitude and violence than that of Nov. 25 last, the damage to the sewer and to property being slight. While this explosion was not in itself extensive or disastrous, it serves to indicate the imminent danger of recurrence of such explosions.

REPAIRS FOLLOWING PREVIOUS EXPLOSION

Since the explosion in November, 1913, the city has been engaged in repairing the damage then caused. Following the completion of the emergency operations required for the opening up of the sewer and for temporary drainage, contracts had been awarded for the permanent repair of those portions of the sewer which had been badly damaged and which required extensive repairs. These contracts had been substantially completed, some backfilling and cleaning up along the line of work remaining to be done. To date the city has expended about $210,000 in making these repairs.

At the lower end of the sewer, between the outlet at the Allegheny River and Penn Avenue, the damage caused by the previous explosion had not been extensive, but the relining of sections and other minor repairs were necessary. Accordingly, early in May a force of city employees began making these repairs, and this work has since been in progress. At the time of the explosion the repair gang had reached a point on Thirty-third Street between the Allegheny Valley Railroad and the river. Before this repair work was started two shafts, each 8 x 10 ft., were excavated and the crown of the sewer removed at these points. These shafts provided adequate ventilation in the sewer, making working conditions very favorable, and also facilitated the handling of materials. As a further means of insuring good ventilation the manhole covers indicated on the accompanying drawing had been removed. The outlet at the river was not submerged, as was the case at the time of the former explosion.

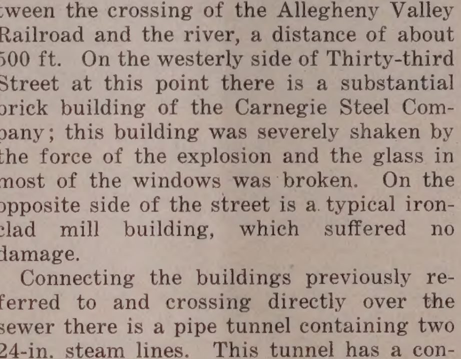
INCIDENTS ATTENDING EXPLOSION

As this repair work had been in progress for several months and had only been interrupted during short periods of heavy precipitation, exceptional opportunity had been afforded to observe conditions in the sewer. Until the day preceding the explosion there was no evidence of unusual gases or gasoline vapor noticeable in the sewer. In fact, conditions were so good that work was proceeding with open lights. On the day before the explosion the odor of gasoline vapor was detected, work was discontinued and an electric-lighting system was installed. Work was resumed the next morning, but the gasoline fumes became so dense that the workmen were ordered out of the sewer.

Within 15 min. after the men had left the sewer the explosion occurred. It was accompanied by a very loud report and flames rose out of shaft A, reaching the under side of the elevated-railroad structure, a height of about 20 ft. The portion of the sewer affected extended from Penn Avenue to the outlet at the river, a distance of about 1500 lin. ft., the greatest force being concentrated in a section midway between the crossing of the Allegheny Valley Railroad and the river, a distance of about 500 ft. On the westerly side of Thirty-third Street at this point there is a substantial brick building of the Carnegie Steel Company; this building was severely shaken by the force of the explosion and the glass in most of the windows was broken. On the opposite side of the street is a typical ironclad mill building, which suffered no damage.

Connecting the buildings previously referred to and crossing directly over the sewer there is a pipe tunnel containing two 24-in. steam lines. This tunnel has a connection with the sewer. Its roof was damaged both in the street and within the building. At the time of the explosion the mills were in operation and a number of employees were injured by flying glass. There were, however, no injuries of a serious nature.

The sewer in which the explosion occurred is a brick-and-stone structure, 10 ft. in width and 8 ft. in height. The hydraulic grade of the sewer is about 1 per cent, this grade continuing some distance up the valley. The cover over the sewer ranges from 4 ft. at Penn Avenue to about 14 ft. near the outlet. The cross-section of the sewer is shown on the accompanying sketch.



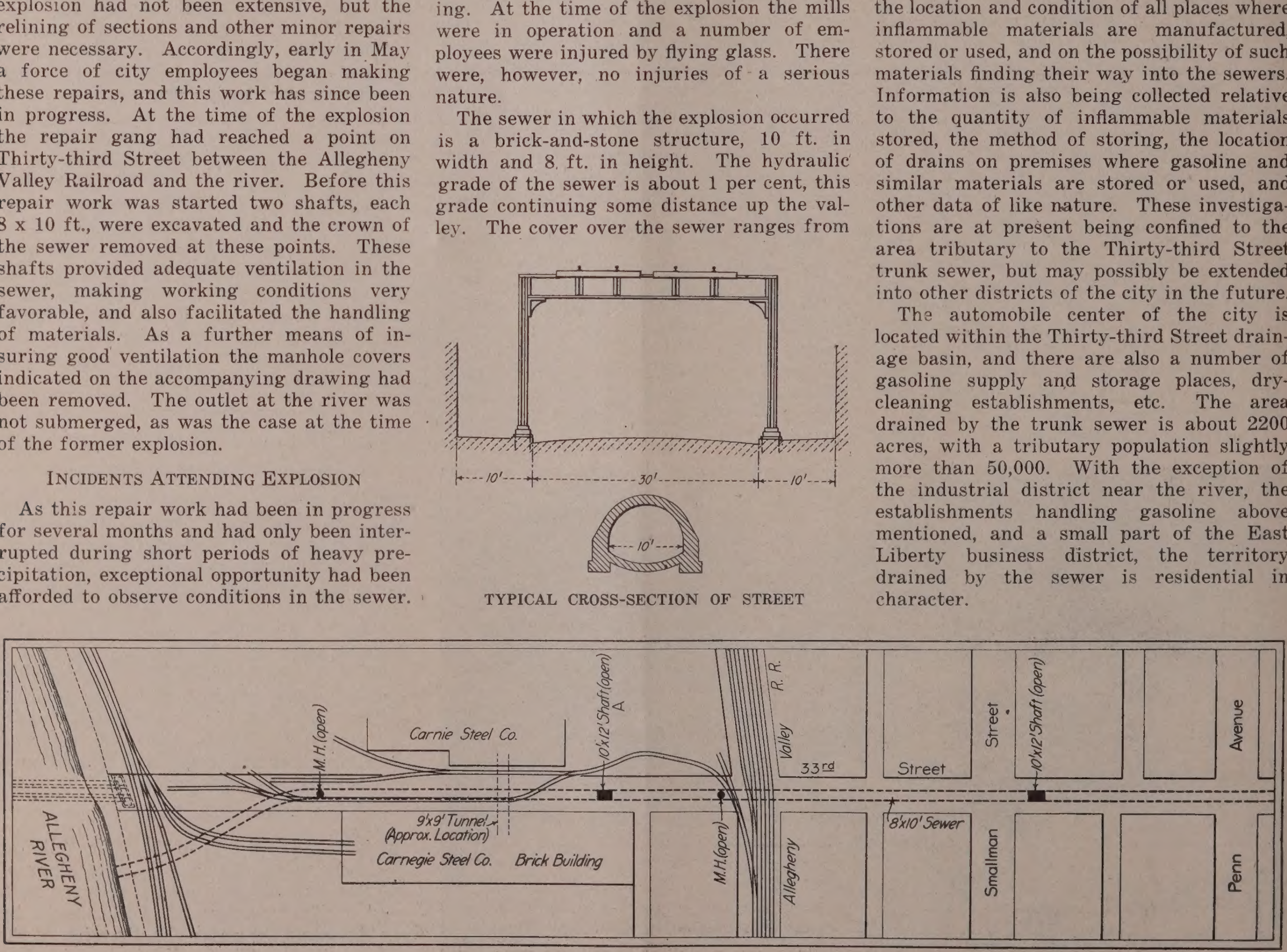
TYPICAL CROSS-SECTION OF STREET

CAUSE AND INVESTIGATION

While the cause of the explosion is definitely ascribed to the presence of gasoline in the sewer, the manner in which ignition took place is unknown. Owing to the industrial character of the district and the fact that the shafts and manholes were open, the gas could have been ignited in a number of ways, but it seems most probable that the gas was ignited by sparks either from the mills or from passing locomotives on the viaduct overhead or operating on tracks in the vicinity. It is also possible that a match or lighted cigar was carelessly thrown into one of the openings into the sewer.

It is the intention of the city to make a thorough and exhaustive investigation to determine the causes of sewer explosions, the conditions under which such explosions take place, and the sources, nature and quantity of inflammable wastes discharged into the sewers. This investigation will probably be made under the direction of the U. S. Bureau of Mines in conjunction with the city departments. This investigation has already been begun. On the afternoon following the explosion samples of air were collected from within the sewer at a number of points, extending several thousand feet up the valley above the vicinity of the explosion. Also a force of inspectors has been organized and a systematic investigation begun to examine into and report on the location and condition of all places where inflammable materials are manufactured, stored or used, and on the possibility of such materials finding their way into the sewers. Information is also being collected relative to the quantity of inflammable materials stored, the method of storing, the location of drains on premises where gasoline and similar materials are stored or used, and other data of like nature. These investigations are at present being confined to the area tributary to the Thirty-third Street trunk sewer, but may possibly be extended into other districts of the city in the future.

The automobile center of the city is located within the Thirty-third Street drainage basin, and there are also a number of gasoline supply and storage places, dry-cleaning establishments, etc. The area drained by the trunk sewer is about 2200 acres, with a tributary population slightly more than 50,000. With the exception of the industrial district near the river, the establishments handling gasoline above mentioned, and a small part of the East Liberty business district, the territory drained by the sewer is residential in character.



GENERAL MAP OF AREA AFFECTED BY SECOND EXPLOSION IN TRUNK SEWER AT PITTSBURGH

Explosions in Sewers

Tests as to Explosive Qualities of Different Mixtures of Air and Gasoline Vapors Made at Yale University

IN the Engineering Record of Feb. 28, 1914, page 260, there was an abstract of a paper with the foregoing title, which had been read by H. J. Kellogg, assistant city engineer, New Haven, Conn., before the Connecticut Society of Civil Engineers. Since the preparation of the paper some tests have been carried on by Prof. A. L. Dean, of Yale University, and are reported by Mr. Kellogg in his closure of the paper, which has recently been issued in completed form. Together with brief data on the tests there is a description of an apparatus designed by Professor Dean for sampling the atmosphere inside the sewer. The notes from Mr. Kellogg's closure are as follows:

Experiments were to determine the proportions of gasoline oil and air that would cause explosions, after the oil had evaporated, trying to find the least amount of oil that would produce such an effect. The apparatus Professor Dean used looked like a large bottle with the bottom cut off, the body being cylindrical. Through the hole at the top of the bottle, or tube, two insulated wires, joined at the ends by a fine platinum wire, were passed and the hole hermetically sealed. This tube was fitted with a cork with a small glass rod running through it, the inserted end of the rod having an asbestos brush fastened to it. The open end of the cylinder was closed for each trial with paraffined paper held by thick varnish on the edge of the glass.

Then a measured quantity of gasoline oil was dropped onto the asbestos brush from a graduated tube, and the cork was pressed home. Turning the glass rod rotated the brush and aided the evaporation of the gasoline into the imprisoned air. As the wires, above mentioned, were connected with a battery of Columbia dry cells, closing the circuit heated the platinum wire and the mixture was ignited. The cylinder held 1200 cu. cm. of air.

The first trial was with 0.24 cu. cm. of gasoline, or 1:5000, and the explosion was a fine one. The next successful shot was with 0.12 cu. cm. of the oil, or 1:10,000. Reducing to 0.06 cu. cm., or to 1:20,000, no explosion followed. Increasing the dose to 0.07 cu. cm., or 1:17,143, resulted in no explosions with two trials. With two trials at 1:15,000, or with 0.08 cu. cm. of oil, two explosions were obtained, showing that, under laboratory conditions, that amount of oil was about the lowest limit. The gasoline used was 76 deg. Baumé and was probably a better grade than the ordinary commercial oil.

Reduced to gallons of oil to cubic feet of air gives 1 gal. to 2000 cu. ft. Adjusting that to the 42-inch James Street sewer shows that, under perfect conditions, 250 lin. ft. of that sewer would be filled with an explosive mixture of gasoline vapor and air by the introduction of 1 gal. of gasoline oil.

SAMPLING APPARATUS

To follow Professor Dean's suggestion of getting samples of sewer air we first intended to get them by entering manholes with jars filled with water and emptying them near the surface of the water. The jars would thus be filled with the air from below, and, if immediately closed with stoppers fitted with sparking plugs, the contents could be tested for explosiveness by a firing battery. But by the time a man could get the jar filled with the suspected atmosphere, ventilation would have changed the gaseous conditions at that locality in the sewer. If the dangerous gas or gases were still present at the manhole in sufficient quantity to be a menace, after such ventilation, it would be no place to send a man of any value to the community.

That difficulty has been overcome by a simple, ingenious and apparently practical apparatus designed by Professor Dean. It consists of a long rubber tube let down into a manhole through the small opening left by just starting off the cover, after sounding for depth to find the length of tube needed to reach nearly to the surface of the stream, a bulb on the upper end of the tube is worked until both the rubber tube and the bulb are filled with the sewer atmosphere. Then a small, collapsed, rubber toy balloon is slipped over the firing end of the short piece of brass tubing to which the long rubber suction tube is also attached. Projecting from the brass tube into the balloon are the ends of two insulated wires from a dry cell battery connected by a fine platinum wire. When the balloon is well filled, by further pumping, the stopcock in the brass tube is shut, to prevent backfiring, and the circuit is closed by pressing the button. When the platinum wire becomes heated, if there is an explosive mixture in the sewer, the contents of the balloon are exploded.

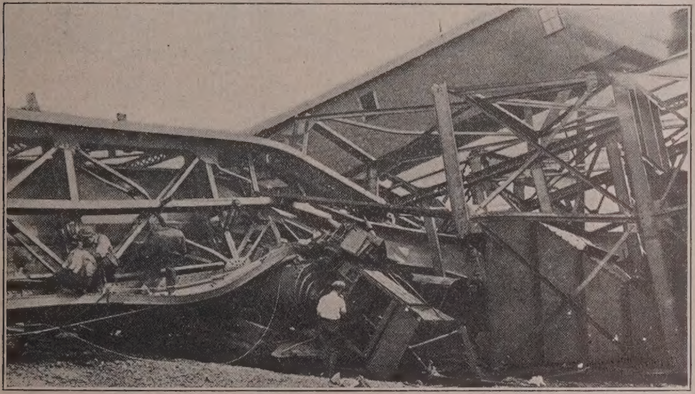
The apparatus was tested at the laboratory by holding the receiving end of the long rubber tube over a beaker into which had been poured a few drops of gasoline, and it worked successfully every time. It showed further that the only thing that could be damaged was the little balloon.

The object of extending the tube to the bottom of the manhole is to get the heavier gasoline vapor. It is not necessary to sound for the lighter illuminating gas. The odor of the latter discloses its presence, but the testing apparatus can be used to find out if enough was present to cause an explosion. The results of the studies made with this apparatus are not yet available. It is proposed to make the results the basis of municipal regulation on the subject of discharge of liquids.

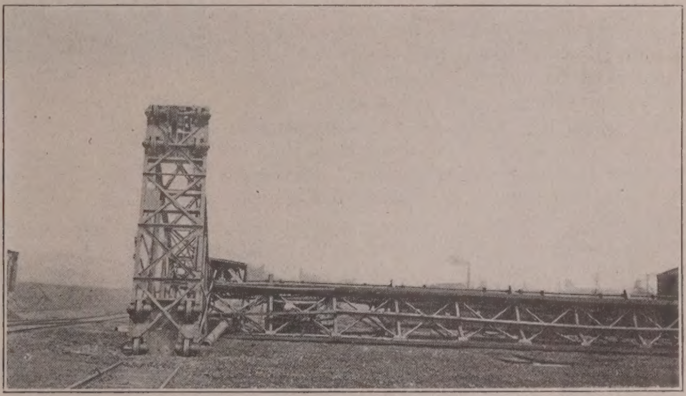
Gantry Bridge Wrecked by Wind

In Spite of Set Brakes, the Structure Was Driven Along Its Track and Capsized on Reaching the End

A GANTRY bridge forming part of the coal-handling apparatus at the Marion (N. J.) power plant of the New Jersey Public Service Corporation ran away and was overturned and completely wrecked in a violent windstorm July 21.



LOCOMOTIVE DRIVEN INTO ASHFILL BY FALLEN GIRDERS



GANTRY GIRDERS AND BELT CONVEYORS WRECKED BY WIND

At this plant coal is delivered from barges to a set of conveyors which either discharge directly to the coal bunkers or to a Robins traveling gantry bridge, equipped with a belt conveyor and automatic tripper, by means of which the coal can be deposited in an outside storage pile under the traveler or can be recovered from this pile and delivered to the bunker conveyors.

The gantry bridge had two lattice-girder trusses of 125-ft. span about 40 ft. high in the clear, mounted on riveted towers moving on a 450-ft. level track and weighing altogether 118 tons. It was exposed to a squall with a reported velocity of 108 mi. per hour, which exerted such a pressure that the locked wheels skidded on the rails, and the other wheels, revolving, allowed the gantry to run the full length of the tracks. When it reached the end of the track it capsized.

The girders fell directly across a standard-gage locomotive and drove its wheels 3 ft. into the ashfill without breaking the boiler or causing an explosion. It was even stated that a previous leak in the boiler was found closed after the accident. Fortunately no persons were injured. The direct and indirect damage was estimated at about $80,000.

A THREE-STORY PIERSHED, 150 ft. wide and nearly 1500 ft. long, is proposed for the new Gladstone Dock 1 at Liverpool, according to a recent consular report. The shed is to be set back from the quay far enough to make room for a traveling crane.

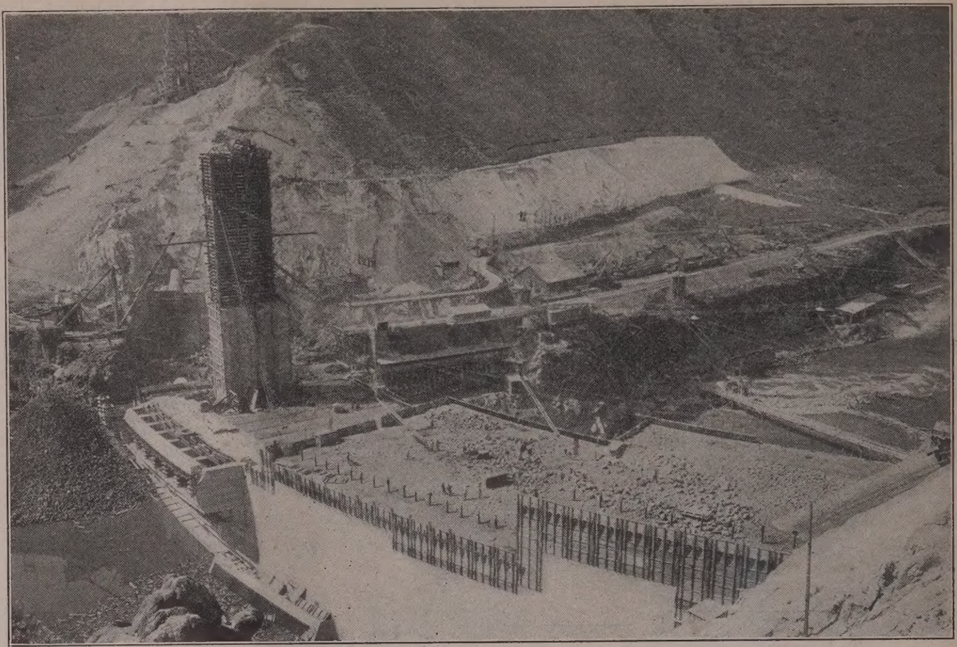
Break in Baffle Wall from Unequal Mud Pressure

Accident in St. Louis as Described in Annual Report of Water Commissioner

FAILURE of a baffle wall from deposited mud causing a difference in head is reported in the last annual report of E. E. Wall, water commissioner of St. Louis. Soundings in basin 9 in May, 1913, when work was to be started on the filter plant within it, indicated heavy deposits of mud from six months' continuous use, but as a number of pressure-relief gates had been placed in the baffle wall to equalize the pressures on both sides no danger of failure was anticipated and the sewer gates were opened early in the afternoon. The next morning a section of the baffle wall 154 ft. long, about equidistant from the ends, was lying on the basin bottom, having failed at the line where the reinforcing bars had been lapped. The depth of mud in front of the wall was 3 ft., while that in the 10-ft. space behind, as determined from the lines on the basin wall, averaged 15 ft.

Most of the deposit behind the wall was heavy, containing sand and standing at an angle of about 75 deg. with the horizontal. A part was softer, the angle at which it would stand being about 50 deg. The mud in front of the wall was stiff enough to prevent the operation of any of the relief gates, except that at the west end, where the rush of the incoming water had prevented the deposit of sediment. The baffle wall was of cantilever design, reinforced to resist wind pressure and 10 ft. of water pressure.

Plans had been prepared in the office requiring the removal of the eastern 300 ft. of this baffle wall and the construction of an inclined weir at the end of the part to remain in place. The break required no change in these plans, and accordingly, after cleaning the basin, the 125 ft. on the east end still standing was thrown down by dynamiting and the whole broken up and removed from the basin. All reinforcing bars were straightened and used in other parts of the work.



GENERAL VIEW OF PLANT AND DAM IN COURSE OF CONSTRUCTION

Crest of finished dam will be just below extreme top of picture

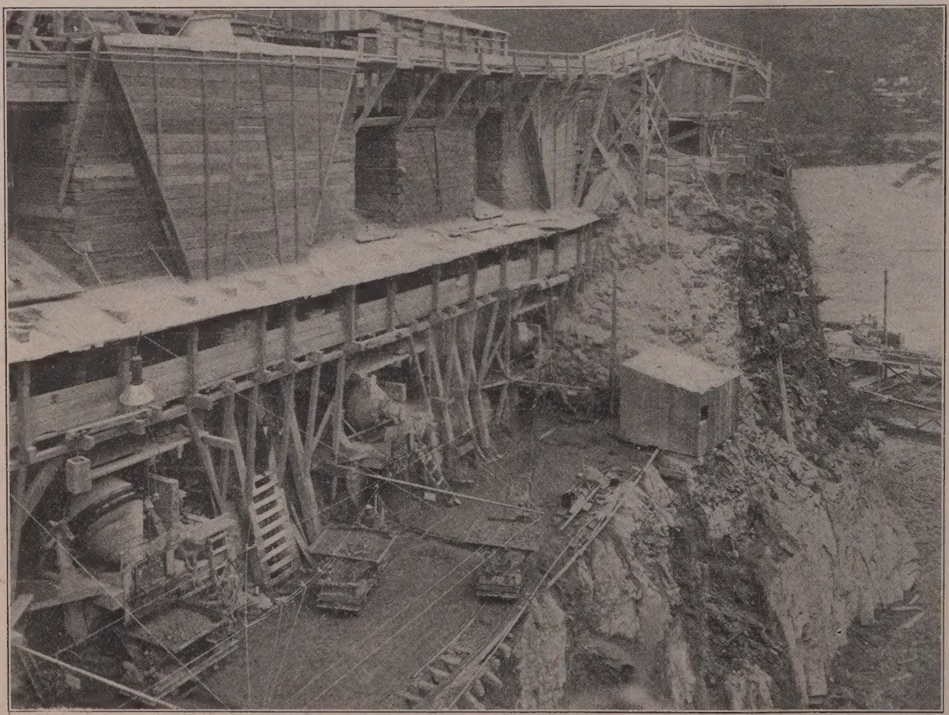
Concreting the Arrowrock Dam

Trolley Dump Cars, Cableway Buckets and Separate Cableway Hoppers with 40-Foot Chutes Are Features of the Three-Unit Plant

By CHARLES H. PAUL
Construction Engineer, U. S. Reclamation Service

CONCRETE in the Arrowrock Dam is being placed at the rate of about 50,000 cu. yd. per month, and at the time of this writing (July) more than 360,000 cu. yd. are in place in the structure.

The Arrowrock Dam, which when completed will be the highest dam in the world, having a maximum height of 350 ft., is being built by the U. S. Reclamation Service for the storage of water for irrigation in connection with the Boise project near Boise, Idaho. Articles descriptive of various features in connection with its construction have appeared in this journal under dates of March 23 and April 6, 1912; Feb. 22, Aug. 2 and Sept. 6, 1913, and Feb. 21 and March 7, 1914.



NEAR VIEW OF CONCRETE-MIXING PLANT AND ELECTRIC DUMP CARS

Material for concrete is being obtained from a gravel pit on the line of the Arrowrock Railroad, about 13 mi. below the dam, where a steam shovel and three dinkey trains are working two shifts per day. A large screening and crushing plant, equipped with six rotary screens and two No. 5 crushers, has been erected at the gravel pit, where the material is screened before being loaded into standard-gage bottom-dump cars and hauled over the Arrowrock Railroad to the dam site. The material is screened to the following sizes: Sand to 3/8 in.; gravel, 3/8 to 2½ in.; cobbles, 2½ to 4½ in. All material rejected by a grizzly with 4½-in. clear openings passes to the crushers and from them back through the screens. Storage bins of suitable size are provided at the screening plant.

From six to eight trainloads per day of this screened material, averaging about 400 cu. yd. per train, are hauled from this screening plant to the mixing plant at Arrowrock, where the standard-gage cars dump direct into the storage bins over the three mixer units.

SAND-CEMENT

Sand-cement consisting of 55 per cent Portland cement and 45 per cent pulverized granite, reground to such a fineness that 90 per cent passes the 200 sieve, is manufactured on the ground at the rate of about 2000 bbl. per day. Ample bin storage is provided, and all sand-cement used in the dam must first pass the boiling test and the 200-lb., seven-day tensile test. Out of nearly 300,000 bbl. manufactured to date there has not yet been a failure of any of this sand-cement to pass these standard tests. The sand-cement from the storage bins is transported across the river to bins over the mixers, through 3-in. pipe lines, by means of compressed air.

The sand, gravel and cobbles from their respective bins at the mixing plant are fed by gravity to the mixers through measuring boxes controlled by gates operated by compressed air. These materials are measured by volume, but the sand-cement is weighed in, on account of the inaccuracy of volume measurement for material of such fineness. The cement-bin gate is operated by hand, and through it the cement is fed into a tight box with a hinged bottom, hung on steel yards. On signal from the mixer man all materials are dumped into the mixer almost simultaneously. Water is added at the mixer.

The concrete is mixed about 1 part sand-cement, $2\frac{1}{2}$ parts sand, $5\frac{1}{2}$ parts gravel and $2\frac{3}{4}$ parts cobbles, but this mix is varied somewhat, as conditions may demand, and a richer mix (about $1:2:4\frac{1}{2}:2\frac{1}{2}$) is used for a thickness of from 5 to 10 ft. against each face.

The Plant

There are three 1-yd. mixers in the plant—each, with its measuring boxes and bins, forming an independent unit. Just below each mixer is a 1-yd. hopper, the gate of which is operated by hand. Each mixer is served by a 2-yd. electric (trolley) rocker dump car which transports the concrete over a level track to the distributing tower, where it is dumped into one of three 2-yd. cableway buckets and distributed by cableway, hopper and chute to any point desired on the work. The cableway bucket dumps automatically through a radial gate into the cableway hopper, from which is hung a chute 40 ft. long, the free end of which is suspended from auxiliary cables, and may be swung at will to any point desired within a circle of 40-ft. radius. The cableway hopper is held stationary by snub lines while actually in use, but its position along the cableway is controlled from the head tower, and it may be moved from point to point with no loss of time between batches.

Ordinarily each mixer unit with its dump car and cableway system is operated as a complete, independent unit, but the arrangements are such that any mixer can feed to any cableway, so that an interruption on any part of any unit causes strictly local trouble, and only a minimum loss of time.

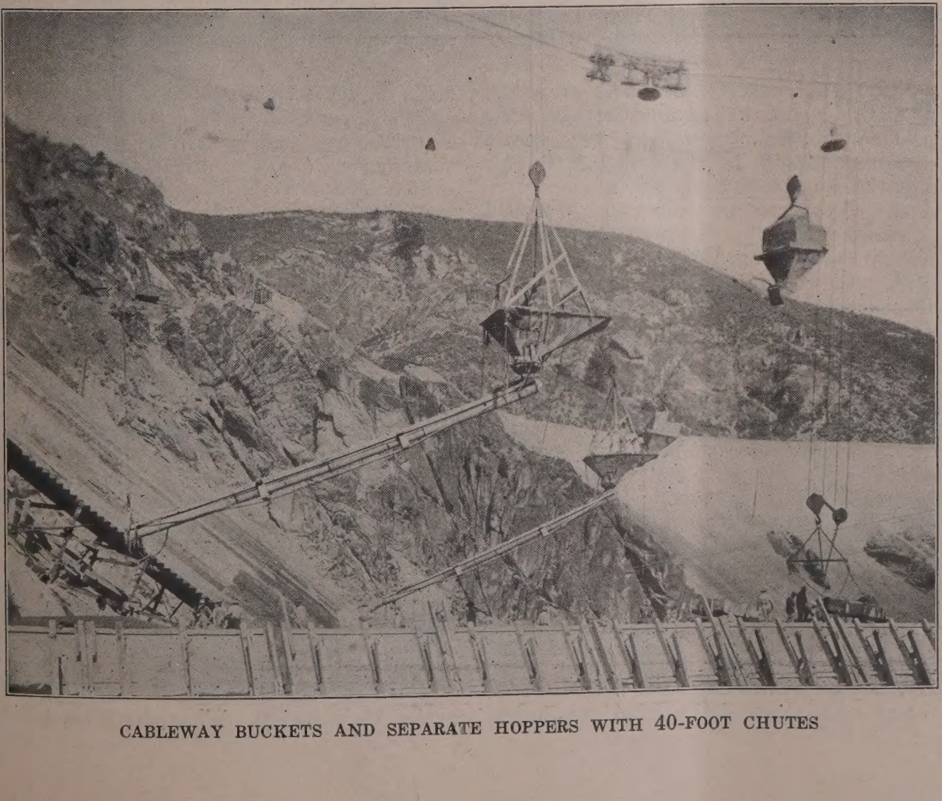
The mixing plant and the standard-gage railroad tracks along the edge of the cliff and on the top of the bins are shown in one of the illustrations. The electric dump cars run on tracks on the platform just below the mixers, passing through a temporary tunnel under the base of the distributing tower. The cableway buckets are lowered down one of the grooves which may be seen in the face of the concrete base of the distributing tower, to the bottom of the sump, where they receive their load from the car.

Some plum rock may be seen scattered over the surface of the concrete. This is brought in by one of the main cableways, which are entirely separate from the concrete-distributing cableways. The common tail tower for the two main cableways may be seen near the upper left-hand corner of the view. No constant supply of plum rock is maintained, but they are placed only when a temporary supply is obtained, conveniently and economically, from the abutment excavation.

A closer view of the mixing plant and the three electric (trolley) dump cars is shown. Two of these are on the way to the tower with their loads, and the third is just being loaded. The mixers are No. 14 1-yd. Smith mixers. The electric dump cars were manufactured especially for this work by the Atlas Car & Manufacturing Company, of Cleveland. The mixing plant turned out 56,500 cu. yd. of concrete during the month of June with two 8-hr. shifts per day for 26 working days.

Cableways

The remaining view shows the cableway hoppers and buckets. The farther bucket is just dumping into the hopper, and the concrete may be seen flowing from the end of the chute. The bucket on the nearer cableway is just approaching the hopper. The radial gate at the bottom may be seen, and the projecting arm, passing just over the horizontal bar between the forward bales of the hopper, opens the gate as the bucket is slightly lowered. The forms for a portion of the inspection gallery up the abutment may be seen in this view at the left.



CABLEWAY BUCKETS AND SEPARATE HOPPERS WITH 40-FOOT CHUTES

The output of the plant for the last three months has been as shown in the table.

Output of Concrete Plant for Three Months

	April	May	June
Total yardage for month....	45,700	51,490	56,520
Number of working days...	26	26	26
Number of 1-yd. mixer hours per day..........	48	48	48
Average yardage per day...	1,760	1,980	2,175

This work is located in the Idaho district of the U. S. Reclamation Service, of which F. E. Weymouth is supervising engineer. James Munn, superintendent of construction, has direct charge of all construction work. A. B. Mayhew, engineer, has charge of the concrete inspection and of all field and office engineering. The details of the cableway distribution system for the concrete were worked out by F. T. Crowe, engineer. The writer has general charge of the construction of the Arrowrock Dam and related features.

Handling Meters in Milwaukee

Testing and Repairing on the Premises; Stock System in the Shop

METER maintenance and handling in Milwaukee cost 32 cents per meter in 1913. This includes the net cost of operating the meter department and is 6 cents more than the expense in 1912, due to the great number of meters taken off for sand troubles. More than 18,000 meters were handled, according to O. F. Poetsch, superintendent of meters, in his statement in the annual report of H. P. Bohmann, superintendent of the water department. Of these 18,000, 2936 were newly set, 7996 were repaired in the shop, 6989 were repaired on the premises and 114 were tested for registration.

From the large number of meters coming in the shop for repairs, by far the majority were brought in on account of failure to register, caused by corrosion of the interior of the cast-iron outer housing, which in time interfered with the operation of the train gear. The galvanized coating of the casing apparently afforded little protection, as meters brought into the shop after a few months of service frequently showed evidence of corrosion. As the water meter is the property of the consumer and must be maintained by him, meter-repair bills are not looked upon with particular favor by the consumer. The department, therefore, decided to prohibit the use of cast-iron meters of the sizes of $\frac{5}{8}$ to 2 in. in diameter, feeling that in so doing a large percentage of repairs would be eliminated.

Water consumption passed through meters was 72.6 per cent of the whole. The per-capita consumption was 111.5 gal. daily and 804 gal. per tap, of which only 370 out of 59,603 are not metered.

Testing and Setting New Meters

The work of putting in services and making connections for meters is done by licensed plumbers. The city inserts the tap and the plumber continues with the work after the tap has been made. Before the water can be turned on the plumber must deliver to the meter division a meter of proper size and make. He is required to make a written application to have a meter set. Upon receiving this application a bill for the testing and setting of the meter is made out.

All meters before being set must test within 1½ per cent on full stream and register on small streams as follows: On ⅝, ¾, 1 and 1¼-in. meters on a 1/16-in. stream; on 1½ and 2-in. meters on a ⅛-in. stream; on 3, 4 and 6-in. meters on a ¼-in. stream. The testing of meters is done by one man, on whom rests the responsibility of the accuracy of the meters leaving the shop. Two Mueller testing devices are used, which have been changed materially so as to permit the testing of all makes and sizes of meters from ⅝ to 4 in. inclusive. One man can handle two testing machines very nicely, and, in case of a rush, a third machine.

In setting new meters a 1-ton truck is sent out with two men. While one man sets the meter the other man, who is a practical plumber fully conversant with the plumbing work, makes a thorough inspection of the entire premises to make sure that all fixtures are controlled by the meter being set.

Five field men are kept busy attending to meters reported as stopped, leaking, broken, etc. These men make repairs to meters on the premises wherever possible. For this purpose they carry a satchel of tools with them. Much of the work is of an emergency nature, such as bad leaks, frozen meters, lack of registration or failure of the consumer to get water on account of the meter stopping.

REPAIR METHODS

All meters in service are privately owned and kept in repair at the expense of the consumers. A machine shop consisting of a shaper, pipe-cutting machine, lathe, wet tool grinder, drill press and speed lathe, all motor-driven, makes possible good work.

All stock purchased is received by the stock clerk, who reports daily on the proper blanks to the superintendent of meters in order that the bills can be correctly checked. A daily report of everything leaving the stock room is made by the clerk on the proper blanks, which show on what work order or repair order each item was used. This sheet goes to the cost clerk daily so that it can be transcribed or posted on his copy of the repair order. The cost clerk also gets the time sheet of each man, which shows the actual time each man spent on each job. In this manner the cost clerk posts the repair parts used and the time spent in repairing on every repair order. When a job is completed a bill is made out. The cost clerk also keeps a card-record stock account of all meter parts, materials and supplies. These are checked out on his cards as the stock is used. All new stock purchased is reported to him so that it can be entered. At the end of each year a physical inventory of stock is taken, which must agree with the stock cards in the general office.

TESTING LARGE METERS

According to the rules and regulations of the department all 3-in. meters or larger are required to have a valve on the inlet side, as well as on the outlet side of the meter. Between the outlet side of the meter and the outlet meter valve a 2-in. or 3-in. testing tee is required for the purpose of making retests on the meter without having to disconnect it. With a crew of three men and a team tests are made on large meters on the premises by connecting a test meter to the testing tee on the meter in service. Depending on the size of the meter, 100, 200 or, in some instances, 500 cu. ft., are first run through the service meter and then through the test meter. A comparison is then made of the registration of both meters. If the variation does not exceed 10 per cent the meter can usually be adjusted without removing it. The water, after passing through the test meter, is conducted to the sewer by means of a hose.

In 1911 the underregistration of large meters tested was 9 per cent, in 1912 it was reduced to 5 per cent and in 1914 it was lowered still further, to 4.4 per cent. The average underregistration on 317 small meters tested was 8 per cent. The disk type of meter, now being installed in smaller sizes, usually retains its accuracy until considerably worn, when the rubber disk will break and stop registration entirely. This will be detected by the meter reader on taking his monthly reading. It is seldom that this type of meter is found to be registering more than 5 to 10 per cent under.

The underregistration on the plunger-type meter, by reason of its construction, will increase according to the wearing of the meter. The wear on this meter is so gradual that it is hard to notice any falling off on its consumption and the error can only be detected by retesting. It will require a large quantity of water to pass through the meter before it becomes sufficiently worn to warrant a retest and adjustment of the meter. It is fair to presume that the smaller sizes do not need as frequent inspection or retest as the larger ones. Many meters of the smaller size can be left in service from ten to twenty years before a retest would be warranted.

Compression Machine for Testing Structural Materials

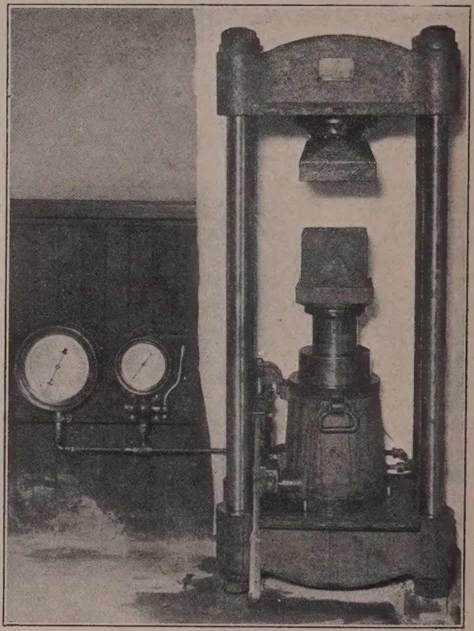
Apparatus Has Capacity of 125 Tons and Combines Low Cost with Small Weight and Floor Area and Low Operating Expense

ECONOMY and safety, it is conceded, both demand that advance tests be made on concrete specimens when large concrete structures are to be built, and it is also required that on important construction blocks of concrete be made up in the field at stated intervals and tested for compressive strength at ages of, say, 7, 14 and 28 days. To obtain a good average sample of concrete, specimens should be cast at least 6 in., and preferably 8 in., in diameter. A machine to test specimens 8 in. in diameter must have a capacity of at least 100 tons. A capacity of 125 to 150 tons is still more preferable, affording a slight excess capacity and also providing for cases where it is desirable to test an old piece of concrete such as is sometimes cut from a wall. With a view to obtaining a reliable, accurate and efficient machine of a capacity up to 125 tons, at a low cost, and requiring comparatively small floor space, a design was developed under the supervision of W. O. Lichtner, who is associated with Sanford E. Thompson, consulting engineer, of Boston, and was described by him at the recent convention of the American Society for Testing Materials. These notes are taken from his paper.

This machine consists of an ordinary hydraulic jack like those used in shipyard work, set in a frame consisting of a heavy base and top. The top of the frame is provided with a head block having a ball-and-socket joint with about ½-in. play in the joint, so as to adjust itself to the specimen and give it a square bearing.

GAGES

To cover the range required by small specimens of mortar and large blocks of concrete, two gages are necessary. These gages are calibrated to read the total pressure on the ram. The small gage registers up to 20,000 lb. by 100-lb. intervals, and the large gage registers up to 250,000 by 1000-lb. intervals, with possibility of interpolation for finer readings. Specimens of small sectional area will break under a comparatively small load on the ram, so it was desirable to be able to take readings by 100-lb. intervals when reading on the small gage. When the pressure on the ram exceeds 20,000 lb. the stopcock on the small gage is turned off, which prevents any further pressure coming on this gage. This arrangement has been found to work very satisfactorily.



VIEW OF COMPRESSION MACHINE

Both gages are equipped with a "maximum hand," which consists of a wire held on the main stem of the gage hand by a spring in the form of a bent wire. This leaves the wire loose enough to be pushed around the dial of the gage, but not so loose as to be jarred out of position when the specimen breaks. The top end of the wire is bent outward so as to be caught by the gage hand as it moves around the dial when the pressure is applied. When the pressure is released, the gage hand returns to zero and leaves the maximum hand to indicate the pressure which was reached when the specimen broke.

In order to protect the large gage from the sudden release of pressure occurring when the specimen breaks, it was found necessary to design a check valve to be inserted in the pressure line to the gage. This check valve consists of a small valve seated by a spring. When the pressure is applied, it forces the valve against the spring, allowing the water to pass into the gage. When a sudden release in pressure takes place, the spring seats the valve and the water in the gage gradually runs back to the pump by means of a very minute bypass, which is in reality only a small scratch on the seat of the valve.

PUMP

The jack is equipped with a single-stroke compound pump. The large plunger is used in raising the ram to a height sufficient to tighten the specimen in the machine, and then this plunger is thrown out of service, which allows the small plunger to operate. The large plunger raises the ram about 0.08 in. per stroke, while the small plunger raises the ram about 0.02 in. per stroke. In applying the load, the ram should be raised at the rate of 0.026 ft. per minute, which can be done by operating the pump handle so as to make a stroke and return in 3½ sec. A clock arrangement is being devised to strike every 3½ sec. so that the man operating the machine can accurately regulate the pumping. When the load on the ram reaches the vicinity of 125,000 lb. or over, a pipe extension about 3 ft. long is put on the end of the 3-ft. pump handle. This gives the operator the necessary leverage to operate the pump without the assistance of another man.

A guard should be placed around the working parts of the machine to protect them and also the operator of the machine from injury when the specimens break. Concrete specimens having a height twice the diameter often break very suddenly, throwing small pieces of the specimen around in all directions.

The frame of the machine measures 20 x 32 x 60 in. high, outside dimensions, and the total weight is about 1½ tons.

COST

Net detail costs of this equipment, complete with all attachments, are approximately as follows:

125-ton 1-in. lift hydraulic jack	$215
Tap jack for attaching gages and ⅜-in. high pressure pipe	10
Frame complete	200
One 8-in. gage to register to 20,000 lb	20
One 10-in. gage to register to 250,000 lb	35
Check valve	5
Stop cock	25
Express and freight	25
Setting up	15
Total	$550

The machine described has been in operation for some time and has been found to give accurate and reliable results. The results have been checked several times by a series of check tests on a large expensive screw machine.

VIEW OF TRESTLE WASHED OUT BY THIS SPRING'S FLOOD

Recent Levee Work to Protect the Imperial Valley

Extracts from Report of Brig.-Gen. W. L. Marshall to the Secretary of the Interior on Work Done to Control This Spring's Floods

On April 22, responding to the call for help from citizens in the Imperial Valley, California, the Secretary of the Interior, with the approval of the President, sent Brig.-Gen. W. L. Marshall, consulting engineer to the Secretary, and former Chief of Engineers, U. S. A., to the valley to direct work for the protection of lands and property. It was necessary to build 3500 ft. of earth levee and 4500 ft. of rock revetment, which, while temporarily satisfactory, will not suffice for permanent protection, as is pointed out below by General Marshall.

General Marshall has rendered his report on the work to the Secretary of the Interior. Extracts from it are, with the Secretary's permission, printed below:

CONDITIONS PRIOR TO 1914

Since 1911 the levee along the Colorado River below the intake of the Imperial Canal for 7 mi., and for much of its length at a short distance from and parallel to the canal, and also very close to the shore line of the Colorado River, has frequently been reported as insecure from attack by the Colorado. The Imperial Valley can never be reasonably safe against overflow, or against a complete discharge of the Colorado River into the Salton Sink, until this front of 7 mi., including the intake and heading of the Imperial Canal, is made safe against caving and a strong levee is constructed from the heading along the Alamo-Paradones divide (or between the two channels) and north of Volcano Lake to the Cerro Prieto on the west side of New River, thus divorcing the Alamo-Salton Sea drainage area from the Colorado River delta.

The occasion of the assignment to me of the protection of this front began in March, 1914, when a breach of the levee near Mile 6 [figured from the intake of the Imperial Canal] was made by undermining and caving. A fund of $30,000 had thereafter been raised and paid to the Southern Pacific Company to close this breach, and before April 23, 1914, had been expended in constructing a trestle 1185 ft. long on the site of the lost levee. On that date the work stopped, leaving the trestle severely attacked and without any protection to the piles at the bottom and very slight enrockment at the abutments of the trestle.

The method adopted of closing the break by constructing a trestle exposed to the full attack of the river, along the site of the destroyed levee, and afterward filling in this trestle with quarry-run stone to the old grade line, did not commend itself to me, but the plan was far advanced and could be made effective if the work could be done in time. Thirty thousand dollars had been invested in it, and it seemed a case where it was necessary to invest further funds at a disadvantage; but inquiries were instituted in the vicinity in Mexico and in the United States for outfits of levee builders, animals and excavating tools, and all available were located, awaiting further consideration.

On April 28 I departed from Yuma to Tucson, Ariz., and the next morning conferred with Epes Randolph, president and

RELATION OF WATER LINE TO ENROCKMENT ON MAY 25, 1914, AND VIEW AT SAME POINT ON JUNE 16 chief engineer of the Southern Pacific lines in Mexico, and he made a proposition, including, among other minor projects, a price of 40 cents a cubic yard for 90,000 cu. yd. or more of rock filling in place to complete the restoration of the levee on its former site. After conferring with the Secretary of the Interior this proposition was accepted, but about 2 p. m. May 1 information was received that the piles in the trestle were washing out, and at once Mr. Randolph was notified that the contract must be annulled and the trestle plan dropped. A view of the wrecked trestle is shown in one of the illustrations.

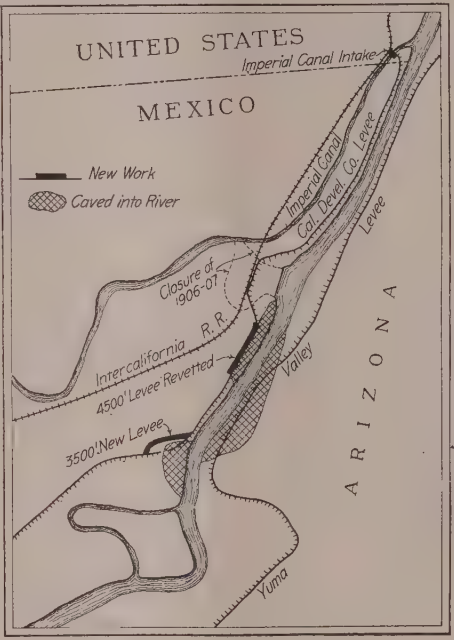
I then laid out on the ground a short line of levee—about 3500 ft. in length, more or less—and directed Mr. Anderson, chief engineer, Imperial Irrigation District, who had been assigned to the work by his superiors, to get his forces on the ground at the earliest practicable moment. He began preparations at once and at 10 a. m. May 3 established an engineer camp, with mess outfits, and began clearing the base of the levee with 25 men and 4 teams. This force was increased as rapidly as teams and scrapers could be found, until by May 24, 1914, we had 43 teams and scrapers, 2 wagons, 5 saddle horses and 3 plows at work, and by May 30 the levee had been completed and its water side protected by brush and sandbag revetment, and all the men, animals, and camp equipment were shipped to their destinations. All supplies, food, etc., were subject to the Mexican customs tariff, which amounted to an average of about 60 per cent of value in the United States; on some articles the tariff was as high as 800 per cent. About 25,000 cu. yd. of earth were moved (much of it unfit for levee building), costing, including overhead charges, duties and all, less than $12,000.

REVETMENT

The break in the levee at Mile 7 never gave me any anxiety. The ground level is high and the overflow would not be great enough to do much damage in the short time of flood, but extensive caving of banks for the 7 mi. north of this break has been expected by me to set in at any time since 1910, and will prove most disastrous if not prevented. I kept up then a nearly continuous watch over this section and on May 9 noticed a small caving, or rather wearing, of the bank a short distance below House 5, immediately below the old break, closed in 1906-7. The bank of the river at the time varied from 95 to 300 ft. from the levee, and a breach here, if it progressed a material distance inland, would allow water to flow into the Paradones, and also directly into the Imperial Canal below the break of 1904-6.

There was only one recourse, or even method to prevent this destruction of the levee should caving set in, and that was to strew and pile stone along the base of the levee to cave or be thrown into the river sufficient in amount to blanket the underwater slopes of the caving bank, and thus stop erosion. That such method is effective on the Colorado River, where floods are short and the depths of water against a caving bank seldom exceed 25 or 30 ft., was demonstrated a year or more ago by F. L. Sellew, who stopped caving just below the bridge at Yuma, and also quite extensively near and below the Laguna Dam, along the Yuma reservation levee. The Southern Pacific Company only could get together adequate equipment for the work, and I accordingly again took the train for Tucson. Mr. Randolph, for the Southern Pacific, agreed to dump 20,000 cu. yd. of Andrade stone along the base of the threatened levee at an average rate of 7 cu. yd. of stone to the linear foot of levee at a reasonable price.

Dumping of stone was expected to begin within 48 hr., but the Southern Pacific had no side-dump cars available, but expected to use flat cars with a Lidgerwood plow unloader. Loss of time resulted from trials and adjustments of unloader, etc., which came near resulting in a loss, for caving set in rapidly. Little rock was dumped up to May 25, and caving had reached the toe of the levee, when, after appeals from me to properly instruct his men, Mr. Randolph arrived at Andrade on May 26 and took personal charge of the situation, and remained in charge for two days and nights, and most effectively cured the unsatisfactory conditions. By this time the water reached several hundreds of feet of the base of the levee, but under Mr. Randolph's personal efforts stone was rushed in, effectively placed, and the levee preserved intact.



MAP OF AFFECTED DISTRICT

COMPLETION OF REVETMENT

From that date the enrockment proceeded rapidly, intelligently, and satisfactorily, until the entire amount covered by the original and extended contracts, 28,000 cu. yd. in all, had been placed along 4500 lin. ft. of levee, 4000 ft. of which were exposed to attack and would ere this have caved into the river had the diagnosis not been correct and the rock properly placed.

It must not be understood that this part of the levee is considered safe. It may be safe against this flood, but it is not at all secure against long attack and consequent undermining of the revetment at bottom of the slope. There are required at least 5 or 6 cu. yd. more to the linear foot of bank, all cast into the water below high-water level and down the submerged slope, in order that on further deepening of the channel against the bank the continuity and thickness of the stone 'blanket may be preserved. Should the continuity be broken, the earth would be exposed and caving would probably set in again.

The work of rock placing was completed on June 15, 1914, at a cost for stone of $33,000, leaving nearly a mile of exposed levee between our work and the closed break at Mile 7, that will cave into the river unless carefully revetted with stone. It is understood that the irrigation districts will continue the work on the same plan.

The total expenditures will amount to about $48,000. The exact amount can only be stated when all charges are paid. The cost of the bank work was very low, compared with bank revetments elsewhere.

Moving a Steam Shovel by Two Cableways

Aerial Passage of 40-Ton Excavator Accomplished Easily and Quickly, Avoiding a Long Circuit by Road

A STEAM shovel being handled by two cableways is shown on the front cover. This was done at the Olive Bridge dam for the Ashokan reservoir of the New York City Catskill Aqueduct. The shovel weighed 40 tons. Its quick trip across the gorge of Esopus Creek saved it a roundabout journey by road.

In moving it the boom was removed for greater stability and the hoisting tackles were attached directly to the steam shovel without using the spreader bars seen in the picture, which were allowed to remain in position to avoid the trouble of disconnecting and reconnecting them.

The cableways were two or four Lidgerwood cableways of 1534-ft. span across the gorge. They were normally used for handling the excavated material from the creek bed and the concrete blocks and mass concrete for the 1000 x 250-ft. masonry section of the dam and for shifting the derricks used on the work.

Few Leaks in Concrete Pressure Conduit

LEAKS in a concrete pressure conduit 1885 ft. in length and 7 ft. in diameter which led from the basins to the pumping station at the Bissells Point water intake in St. Louis were comparatively few, according to the annual report of the water commissioner, despite the fact that work was carried on at temperatures ranging from 70 to 20 deg. Fahr., and that the conduit was exposed during the most severe weather. No temperature cracks were apparent and the comparatively few leaks that did show up were near the top at the end of a day's work and where a dry mix was used. The leaks were easily repaired and the conduit was made watertight before backfilling began. All concrete was of gravel with cement and sand in such proportions that one sack of cement produced 4½ cu. ft. of concrete. Twelve pounds of hydrated lime were added to each sack of cement and the mixture was retained in a batch mixer for 3 min.

A NEW RAILWAY from Paris to Havre is under consideration, according to a recent consular report. The existing line, 142 mi. long, is unable to handle adequately the business offered, which is said to exceed that of any other line in France. Estimates have been made for a second line, and it is figured that such a line could be built for $16,405,000.

Economical Design of the Flat-Slab System

Derivation of Formulæ for Determining Proper Length of Span, Thickness of Slab and Weight of Steel Reinforcement

By **FRANK H. CARTER**
Assoc. M. Am. Soc. C. E., Cambridge, Mass.

REINFORCED concrete of the flat-slab system lends itself admirably to the economical design of floor slabs under piers for buildings, filters, covered reservoirs and the like, as well as for floors of ordinary buildings. Its adaptability is especially apparent for floors under structures where there is a probability of unequal settlement due to varying underlying strata.

Determination of the economical span or the economical thickness of floors has heretofore been a matter of cut and try, with its accompanying labor, leaving in the mind of the designer at times a doubt as to the economy of the final result. The following data were partly evolved from the design of a floor for a clear-water well under a filter recently, and have been amplified for the present discussion, using as a basis the remarkably simple formulæ of A. B. McMillan, civil engineer, with the Aberthaw Construction Company, of Boston. (See Engineering Record of April 9, 1910, page 493.)

Let L and B = length and breadth respectively of panel in feet. When the panel is square $L = B$. When the panel is rectangular, L is greater than B and must be used in computing the bending moment. Let f_s = tension in steel = 12,000 lb. per square inch; d, effective depth of slab; jd, arm of forces = $0.86d$; N, number of bars in panel; a, area of single bar; A_s, area of steel = Na; N_1, number of bars in band; w, live load per square foot; q, dead load per square foot; Y, width of band of steel; V, fiber stress of concrete in shear = 80 lb. per square inch; T, total thickness of slab, and D, diameter of cap. Then

$$W = (w + q)\ LB \qquad (1)$$

$$M = (12/25)\ WL \qquad (2)$$

$$\Sigma A_s = M/jdf_s \qquad (3)$$

$$N = \Sigma A_s/a \qquad (4)$$

$$N_1 = N/4 \qquad (5)$$

$$D = W/\pi TV \qquad (6)$$

$$Y = (7/16)\ L \text{ (approximately)} \qquad (7)$$

From these equations the following expression for the weight of steel reinforcement for panel W_s is obtained:

$$W_s = 3.33\,M\ (L + B + 2\sqrt{L^2 + B^2})/4\,jdf_s + 3.33\,\pi\ (7/16)\ L + 4 \times (7/16) \times 3.33\,L,$$

the last two terms representing the metal required over each pier, in which the reinforcement is assumed to be 1-in. square rods in all cases. Substituting for M its value and simplifying,

$$W_s = [0.4\,L^2B\ (w + q)\ (L + B + Z\sqrt{L^2 + B^2})]/jdf_s + 4.58\,L + 5.85\,L$$

Letting $L = B$ and simplifying the weight of steel per square foot, the equation becomes

$$W_s = [0.000189\ (w + q)\ L^4/d + 10.4\ L]/L^2$$

$$W_s = 0.000189\ (w + q)\ L^2/d + 10.4/L \qquad (8)$$

This is shown graphically in Fig. 1.

The method of procedure in designing the structure is as follows: It is generally accepted that the width of a square pier should not be less than about one-tenth of its height, and the height of a pier is almost always determined from other circumstances than structural design.

Assuming 15 ft. as the height of pier required, we should have, by the rule, a pier 18 x 18 in. in cross-section, which at 12 tons per square foot carrying capacity will bear a load of 27 tons. Most soft ground will safely bear at least 1 ton per square foot, hence as the concrete is assumed to be working up to its limit according to current practice in pier design for filters and covered reservoirs, the resulting spacing of the piers (5.2 ft.) suggests that the piers should be made larger to distribute the pier load uniformly. Obviously, therefore, the piers may be neglected from further consideration of the problem of economical design, except, as mentioned in the final paragraph, that the cost of piers themselves should be combined with the cost per square foot of floor or roof to obtain the maximum economy.

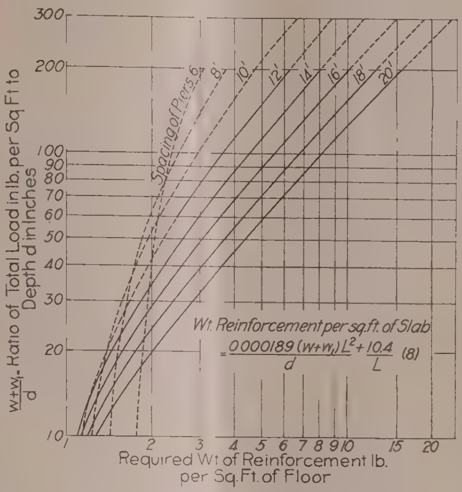


FIG. 1—WEIGHT OF REINFORCEMENT

Neglecting the cost of the piers, the economical depth of slab is determined from equation (8) by introducing the element of costs of concrete with the expression and assigning definite unit costs to both concrete and steel. Then if C = cost per square foot of slab,

$$C = [(d + 1.25) \times \$6]/(12 \times 27) + \$0.0275\ [0.000189\,(w + q)\,L^2/D + 10.4/L]$$

Simplifying the expression and differentiating with respect to d,

$$\mathrm{d}\ (C)/\mathrm{d}d = 0.0185 - 0.0000052\ (w + q)\ L^2/d^2$$

Equating the first derivative to zero and solving for d we get

$$d = 0.0166\ L \sqrt{(w + q)} \qquad (9)$$

This is shown graphically in Fig. 2.

Experience in this kind of work has shown that d should not be less than 6 in.

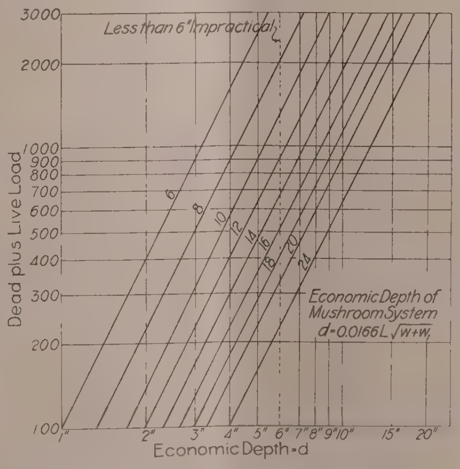


FIG. 2—ECONOMICAL DEPTH OF SLAB

Substituting the value in equation (9) and solving for L,

$$L = (6/0.0166)\ \sqrt{w + q} = 360/\sqrt{w + q} \qquad (10)$$

(a minimum value of L for economy.)

From an examination of the diagram in Fig. 1 it is obvious that for heavy loads the minimum span is the cheapest. All designs should be examined from this standpoint, a comparatively easy matter if diagrams of Figs. 1 and 2 are used.

It is clear that similar reasoning may be applied to warehouse floors. Because of the fact that it is impossible (practically) to build a floor by this system much less than 7 in. in total thickness, equation (10) represents the ordinary relations between span and total load, while equation (8), with its graphical representation in Fig. 1, may be used in estimating the weight of steel reinforcement needed per square foot of floor.

It is, of course, obvious that this discussion neglects the cost of columns, which, because of extreme variations in height, must be treated separately. By means of the diagrams, however, their cost may be readily combined with the cost per square foot of slab to obtain the maximum economy for a given height of column.

Moving a 40-Ton Rock without Injury to Pavements

Precautions Taken to Protect Streets of North Tarrytown, N. Y., against Passage of Huge Boulder

WHEN workmen prepared recently to start a granite boulder weighing 40 tons on its 3-mi. journey from Tarrytown, N. Y., to the estate of John D. Rockefeller at Pocantico Hills the officials of North Tarrytown immediately demanded a $50,000 bond for the protection of the roads over which the stone was to pass. Although this provision was eventually not insisted upon, other precautions were taken which sent the rock by a roundabout route, to avoid unfit bridges, requiring six days for the trip, and no damage, according to Eberhard J. Wulff, superintendent of highways for Westchester County, resulted to the roads traversed.

The stone was crated in a large wooden box supported by two substantial skids made of yellow-pine sill timbers, about 12 x 12 in., braced vertically and laterally to the framework of the box. A heavy plank track about 300 ft. long was laid and at opposite ends were stationed the crated stone resting on rollers and a hoisting engine straining on the stone with a cable. When the stone was drawn up to the engine, the track was moved ahead, the engine propelled to the further end and the operation repeated. Besides the hoisting engineer and fireman there were required about twelve workmen to facilitate the rock's passage.

Mr. Wulff states that several grades in excess of 10 per cent were encountered on the route, but that despite these and the other difficulties a careful investigation of the road has failed to show a single crack in any of the brick pavements or any depression in the macadam pavements.

RAILWAY MILEAGE in Russia is reported to total 43,788, of which 29,594 mi. are Government owned. This does not include 2430 mi. in Finland, nor the 1073 mi. of the Eastern Chinese Railroad.

Report of Consulting Engineers on Miami Flood-Prevention Plans

Special Board Declares in Favor of Detention-Basin Scheme after Reviewing Advantages of Channel Enlargement and Reservoirs

As the readers of the Engineering Record know, the Morgan Engineering Company, of Memphis, Tenn., immediately after the flood of March, 1913, was called in by the Dayton Flood Prevention Committee to devise prevention plans. This organization, after careful study, decided that a reservoir, or "detention-basin" system, was the only feasible solution. In this it was supported by the consulting engineers to the committee, D. W. Mead, J. W. Alvord and S. M. Woodward. Wishing, however, to secure the advice of a group of men of the widest possible engineering experience, the committee decided to appoint a special board of consulting engineers to pass on the plans. It is this board whose report has now been made public. The decision of the Morgan Engineering Company and of Messrs. Mead, Alvord and Woodward is endorsed—in other words, the detention-basin plan is approved.

The members of the board are Brig.-Gen. O. H. Ernst, Corps of Engineers, U. S. A., retired, selected by his fellow-members as chairman of the board of consulting engineers; Brig.-Gen. H. M. Chittenden, Corps of Engineers, U. S. A., retired; Col. J. A. Ockerson, member of the Mississippi River Commission; J. H. Fuertes, consulting engineer, of New York; Morris Knowles, consulting engineer, and former member of the Pittsburgh Flood Commission; T. W. Jaycox, consulting engineer, of Denver; C. H. Miller, of the Miller Engineering Company, of Little Rock, Ark.; W. A. O'Brien, chief engineer, Little River Drainage District, Cape Girardeau, Mo.

The board's opinion, briefly summarized in the report, is:

1. That floods as great as that of 1913, and even greater, are liable to occur at any time, and preventive measures should be carried out which will control floods about 20 per cent greater than that of 1913.
2. That permanent flood protection for the Miami Valley by means of channel enlargement alone is impracticable.
3. That detention basins, supplemented by limited channel improvement, do offer a satisfactory solution of the problem.
4. That the success of such plan for flood control requires that the flooded area of the Miami Valley above the Whitewater River be considered as a unit.
5. That works of the type suggested, properly designed, located, and constructed, will not only provide satisfactory and economical protection from floods, but they will be so massive and substantial as to fully justify confidence in their integrity and satisfy every reasonable question of stability.

The following extracts give the most important parts of the report:

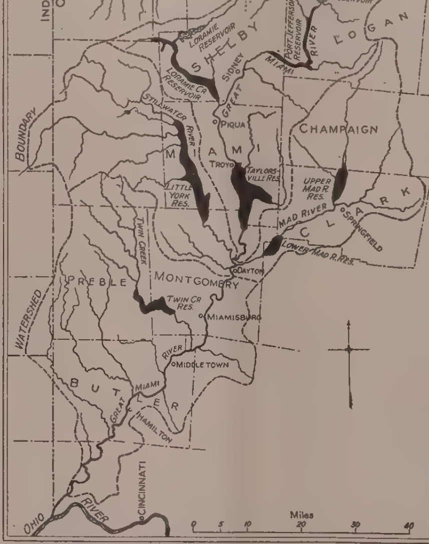
NATURAL FEATURES AND CONDITIONS

The drainage basin of the Miami above the mouth of the Whitewater (which enters the Miami only a few miles above the Ohio confluence, and is not shown on the map herewith) has an area of approximately 3800 sq. mi. On the southeast side of the watershed the divide lies quite close to the Miami and its principal eastern tributary—Mad River, fully 90 per cent of the watershed being to the north of these streams. The country is rolling, with a small percentage of steep slopes, the greater part being suited to agricultural operations. The chief topographic feature which makes the basin one of strong flood possibilities is the compact shape of the watershed, which increases the probability that most of it may be simultaneously subject to a single storm, and the manner in which the tributaries converge upon the main valley, particularly at Dayton. These circumstances make it quite certain that in any general storm the runoff will reach the main stream all along its course above Dayton practically at the same time, and earlier flood stages will be due to these local accessions rather than to a movement of the flood wave down the valley. This condition was forcibly illustrated in the March, 1913, flood, in which the flood rose to its crest practically simultaneously along the entire valley above Dayton.

The flood plain itself of the trunk stream varies in width from a few hundred feet to nearly 4 mi. The narrowest part is just above Sidney, where the width is only 400 ft. The widest part is just below Troy, where the width is 19,000 ft. In the city of Dayton it is about 8000 ft.; at Miamisburg, 2700 ft.; at Franklin, 7800 ft.; at Hamilton, 6500 ft. The total area submerged along the main stream and the Stillwater and Mad Rivers by the flood of 1913 was about 160 sq. mi., or 100,000 acres.

REMEDIAL MEASURES

In considering plans for the prevention of future flood disasters in the Miami Valley the question arises as to whether it will be sufficient to provide for a flood like that of 1913, or whether provision should be made for a still greater flood. So far as existing records go, there has never been in the valley an overflow equal to that of 1913. It is possible that the quantity of water which passed down in the flood of 1805 was equal to that of 1913, but the bottoms being unobstructed by artificial works may have carried it without so great an overflow. The information available is not sufficient to decide this point. The flood of 1866, though a very great flood, was clearly of smaller magnitude than that of 1913. In studying the record of storms which have occurred in the Ohio basin it appears that at least one storm—that of October, 1910, in eastern Missouri, western Kentucky, and southern Illinois—exceeded that of 1913 in intensity and the area of territory covered. If that storm had fallen upon the watershed of the Miami River it might possibly have produced a greater flood than that of 1913, though the season of the year would have been favorable to a considerable storage as ground water. The board considers it within the limits of probability that a flood as great as that of 1913, or even greater, may at any time occur in this valley, and recommends that protection works provide for a material factor of safety over the recent flood.



MAP OF MIAMI RIVER DISTRICT

TWO GENERAL METHODS

There are two general methods, distinct in principle from each other, by which flood prevention can be accomplished. The first is by the enlargement of channel cross-sections by dredging, deepening, widening, and the removal of obstructions or the construction of levees. Enlargement by excavation will not be permanent, and it sometimes happens that the course of development on the banks of streams makes the efficient use of levees impracticable, owing to the necessary changes of grades, bridges, etc., and the difficulty of handling sewage and the tributaries. These drawbacks may be of such magnitude as to compel a resort to the second method of flood control, namely, by works designed to restrain the flow of the streams for a period after the storm has fallen upon the watershed.

This is the "reservoir" system of control of floods. It is not a new system, though comparatively few reservoirs have been built for the exclusive purpose of flood protection. In principle the system is ideal, because it means the detention, or holding back, of the excessive flow of the streams, and letting the waters out gradually. The great advantages of this method are frequently offset by the difficulty of finding suitable sites within reasonable cost. The necessity of flooding villages, farms, highways and railroads may make the best of reservoir sites impracticable of utilization. It thus results that neither of the methods above outlined is of universal application. Each has its advantages, and each may be exclusively employed in a situation adapted to its use.

CHANNEL ENLARGEMENT BY DEEPENING AND WIDENING

Coming to a specific consideration of channel enlargement in the problem here under consideration, it is the opinion of the board that this method is impracticable. Aside from its excessive cost, the method itself is defective. It is calling upon the river to maintain a channel of regular dimensions, while the nature and tendency of the stream are just the reverse. The Miami River, like all rivers, consists of a series of pools and bars. Remove the bars by excavation and the river immediately sets at work to restore them. Excavate the channel below the mouths of the tributaries and these streams immediately begin to cut back their beds until natural slopes are restored, pouring into the river during this process a large amount of channel-choking material.

The size of the channel to carry safely a flood volume like that of 1913 would be many times its present cross-section (see next paragraph). While it would be physically possible to dig such a channel, it would not even then give permanent flood control. The high velocities of even a moderate flood might readily throw up barriers of gravel and rock, as was done in the recent flood, in which case the channel capacity would be greatly reduced, if not obliterated. The tendency would continually be toward a return to its original condition, and its maintenance would require constant work. It is practically certain that if the channel were once enlarged and then left to itself for a very few years, it would not be in condition to do the work expected of it during time of flood. The lining of the bed with concrete or stone would be an undertaking too great to deserve serious consideration. Then there is the cost of maintenance, which, though indeterminate in amount, would surely be very great.

TABLE 1—CHANNEL CAPACITIES COMPARED WITH FLOOD MEASUREMENTS

Stream and location	Approximate Channel capacity in sec. ft.	Estimate of Flood discharge in sec. ft.
Mad River—		
Springfield	10,000	55,400
Osborn	12,000	75,700
Stillwater River—		
Above Covington	2,000	33,100
At Covington	5,000	33,100
Sugar Grove	8,000	51,400
West Milton	8,000	86,200
Little York	12,000	85,400
Twin Creek—		
Above Germantown	8,000	66,000
Great Miami River—		
Above Sidney	8,000	34,100
At Sidney	15,000	44,000
Below Sidney	8,000	48,500
Below Piqua	10,000	70,000
At Troy	12,000	109,700
Tadmor	12,000	127,300
At Dayton	80,000	*250,000
Below Miamisburg	25,000	257,000
At Hamilton	100,000	*354,000
Below Miamitown	40,000	384,000
Loramie Creek—		
West of Lockington	1,000	25,600

*Estimated from other measurements.

Table 1 gives, for various points on the principal streams, a comparison between the estimate of the present channel capacity at bankful stage and the maximum discharge that occurred during the flood of March 23-27, 1913.

CHANNEL ENLARGEMENT BY LEVEES

As to the use of levees, the situation prohibits any extensive increase in their present height. It might be possible to raise the levees with a limited amount of widening of the river channel so that the stream would carry a flood like that of 1913, but they would have to be raised to such a height as to require a complete change of grade of railroads and cause steep gradients of approach at the several street crossings, together with a reconstruction of the bridges on the river. There would also be the problem of disposing of sewage during periods of high water and of leveeing the tributaries back from the main stream to high ground. In cities where the banks of the river are already fully occupied and solidly built up on both sides the necessary changes involved in a levee system make the cost of that system prohibitory.

While it is, perhaps, possible for an individual community to protect itself by means of channel improvement and levees, the initial cost and maintenance of such flood protection might far exceed the expense of protecting the entire Miami Valley by means of detention basins. Taking all into consideration, however, it is the conclusion of the board that channel enlargement applied generally to the Miami River is not a practicable method of affording full protection from a flood like that of 1913 throughout the Miami Valley.

DETENTION BASINS

As already stated, the use of detention basins is ideal, and were it not for the difficulty and expense of securing the necessary sites it would undoubtedly find far wider application. It is the only method that promises general relief to the Miami Valley, and, unless it can be applied there, it will be necessary to accept the view that, although certain to occur, no adequate means of protection from future calamitous floods appear to be available.

The term "detention basins" is used because the ordinary functions of storage reservoirs will not be utilized in connection therewith; that is, the dams will not be used for the permanent storing of water for power, domestic supply, irrigation, navigation, or other similar uses. The basins will be used solely for the purpose of flood prevention, and the water will be detained therein only for very short periods, and will be allowed to run out as rapidly as can be done with safety to the valley below. For this reason their use is solely that of detaining the crest of floods for short periods.

A sufficient number of practicable basin sites has been found in the Miami Valley and its tributaries. In addition to these there are in existence two reservoirs built for other purposes, namely, the Lewistown and Loramie Reservoirs. Table 2, giving data pertaining to these detention basins, has been furnished by the Morgan Engineering Company.

EARTH DAM CONSTRUCTION

The board favors the use of earth dams for making the detention basins, as those are best suited to the topographical and geological formations.

A dam without masonry or concrete core walls, and having grassed slopes, is the type naturally suited to the conditions. A method of constrction frequently adopted under similar conditions, termed the modified hydraulic-fill method, contemplates the use of the excellent local morainal or glacial drift found at or near each of the sites. In this method low earth embankments would first be built up near the upstream and downstream toes of the proposed dam, the materials in the embankments being dumped in place from cars. The inside slopes of these embankments would then be sluiced or washed down by streams of water, filling the basin or trench between the embankments and forming a core of clay, sand, and rock dust that will be impervious to water.

TABLE 2—TENTATIVE DATA ON DETENTION BASINS

	Catchment area in sq. mi.	Storage in billion cu. ft.	Storage in inches rainfall	Elevation of spillway	Area submerged at spillway elev. in thousands of acres	Outlet tunnels for 1913 flood	Max. discharge of tunnels in sec. ft.	Maximum height of dam	Length of spillway crest	Spillway capacity in c. f. s. with 10 ft. of freeboard	Spillway capacity in c. f. s. with 5 ft. of freeboard	Rate of runoff in. per 24 hours
Port Jefferson	440	0.995	1.0	980	2.67	4—10x16	20,900	50	700	63,600	123,000	10.4
Loramie Creek	240	4.06	7.3	940	4.90	1—10x10	4,150	70	500	45,400	88,200	13.7
Taylorsville	*1,120	10.50	4.0	820	12.16	3—15x20	39,600	70	1,030	93,600	182,000	6.0
Little York	620	17.80	12.4	885	9.30	1—10x10	5,200	130	800	72,700	141,000	8.4
Twin Creek	280	5.23	8.0	820	3.64	1—10x10	4,800	105	600	54,500	106,000	14.1
Upper Mad	290	5.87	8.7	950	6.20	1—10x10	4,000	70	500	45,400	88,200	11.3
Lower Mad	*630	3.10	2.1	820	4.50	2—15x20	20,000	55	800	72,700	141,000	8.3

*Includes catchment area of upper reservoirs.

A spillway of ample proportions, well below the crest of each dam, should be excavated in and founded upon solid rock, where possible, sufficient to pass the flood flow of the stream. The spillway channel should be protected from erosion and should discharge sufficiently far below the dam to prevent damage thereto.

The outlet conduits should, where possible, be taken out in tunnels through the natural hill formation and discharge into the stream at a safe distance below the dam. When not practicable to use this construction, a solid foundation should be secured.

The outlets of the basins will be permanently open and will be of such capacity that the ordinary flow will pass without any accumulation behind the dams; but in time of high water the surplus, after the discharge reaches a certain stage, will be detained in the basins, and the outflow will be regulated to an amount that can be safely carried away. The quantity of this discharge from the different basins will vary, some requiring a relatively greater outflow than others to prevent the basins filling too rapidly.

THE SYSTEM IN OPERATION

The operation of the detention-basin system has been worked out with considerable care and checked by several members of the board, both in its application to the flood of 1913 and, in an approximate manner, to one about 20 per cent greater. From these determinations it appears that during the flood of 1913 the flood peak at Piqua would have been reduced from about 85,000 to about 45,000 sec.-ft.; at Dayton, from 257,000 sec.-ft. to about 65,000 sec.-ft.; and at Hamilton, from about 329,000 to about 120,000 sec.-ft. With an estimated increase of 20 per cent in the intensity of the storm, the controlled peak at Dayton can be reduced from about 307,000 sec.-ft. to perhaps 80,000 sec.-ft.

An examination of the Miami River shows that at certain points, even with the proposed basin control, there will be a deficiency in channel capacity to carry the outflow from the basins, together with the runoff from the unreservoired areas. It is believed to be thoroughly practicable to secure such required additional capacity, by means of channel enlargement and levees at selected points along most of the main stream and up the more important tributaries. No detailed information is at present available to permit of definite location or extent of such work, or designs and estimates of costs.

We have, in a general way, checked over the various estimates prepared by the Morgan Engineering Company to represent the cost of the different works discussed in this report. As a general proposition, these estimates seem sufficient, but in works of such great magnitude for which working plans have as yet not been prepared, we believe that ample allowances should be made in the preliminary estimates to cover the various divergencies from, and modifications of, these plans, which are sure to be made when the works are actually undertaken. It seems hardly necessary to designate the directions in which extra costs may be required, as the plans so far prepared are of a very general nature and subject to modification.

With the thought of providing for such contingencies, the board feels that for the principal items of expense the unit prices stated below should be used in making up the estimates of cost for engineering and legal expenses and for contingencies.

TABLE 3—UNIT PRICES FOR FIGURING COST OF MIAMI FLOOD PREVENTION WORKS

For Earth Dams	
Earth excavated and placed in dams, etc., per cubic yard	$0.35
Earth excavated and wasted, per cubic yard	.20
Rock excavation, in the open, wasted per cubic yard	.85
Steel sheet piling, in place, per square foot	1.25
Mass concrete work, in place, per cubic yard	9.00
Reinforced concrete, in place, per cubic yard	12.00
Concrete tunnels, in place, per cubic yard	18.00
For Channel Enlargement and Improvement	
Excavation (hydraulic dredging), per cubic yard	$0.20 to $0.30
This price does not include tearing down and moving existing buildings, readjusting and rebuilding sewerage systems, pipes, changing grades of streets, or repairing streets and sidewalks. All these extra expenses must be taken care of independently and in addition to the price above stated for excavation.	
Bridges	
Heavy highway bridges, per square foot of floor	$3.50 to $5
Railway bridges—	
E-60 plate girders, per lineal foot	125
Trusses, single track, per lineal foot	200
Trusses, double track, per lineal foot	400

Applying these units to the quantities placed before us by the Morgan Engineering Company, we are of the opinion that the cost of a complete scheme of flood protection by channel deepening and widening alone, for the entire river, would probably amount to about $100,000,000, and that the cost of maintenance would be relatively heavy. By the system of detention basins, supplemented by limited channel improvement, the cost of the complete flood control will probably fall between $18,000,000 and $20,000,000, and the cost of maintenance will be relatively light.

Quebec Bridge Girders and Wind Anchorage

Features of Stringers, Traction Trusses, 65-Ton Double Floorbeams and Bottom Lateral Connections to Anchor Piers

THE floor system and provision for wind stresses in the 2830-ft. three-span main structure of the Quebec double-track bridge involve some structural features which have been developed to provide solutions for the problems of an unprecedented bridge span, rather than as extensions of ordinary types by increased dimensions. Among them are the pin-connected, box-section floorbeams of great length, depth and weight, the longitudinal girder spans connecting them, the provisions for resisting traction stresses and for the transmission of the heavy lateral stresses to the anchor pier masonry.

STRINGERS AND TRACTION TRUSSES

As the inclinations of the web members of the truss are nearly uniform, the panel lengths vary with the depth of the truss, and the spacing of the floorbeams in the anchor arms varies correspondingly from 28 ft. to 42 ft., the latter distance obtaining in eight panels. There is no floorbeam over the anchor pier where the stringers are continuous from the approach span over the pier to their connections with the L_1 anchor-arm floorbeam, 23 ft. from the pier center.

The track floor is carried on through plate-girder spans seated on the top flanges of the floorbeams. These longitudinal girders extend about 4 ft. above base of rail, thus forming a trough through which the track runs. The top flanges of the girders are reinforced by a channel with its flanges down. The sub-floorbeams are connected to the girders by heavy gusset plates extending to the top flanges of the latter, and tending to make the girders act as guards in case of derailment.

The traction truss is a lattice girder 22 ft. deep, connected to, and in the plane of, main-truss diagonals AM8-AL10, just clear of the bottom flanges of the longitudinal floor girders.

Expansion joints are provided for the stringers at both ends of the anchor-arm span and intermediately at F_7, and the floor system is stiffened against longitudinal stresses by a traction truss in panel 8-9, and by two longitudinal lattice-girder struts that connect the stringer laterals and bottom-chord laterals in the planes of the stringers and are connected to the floorbeam webs in panel 1-2. Provision is made for a temperature variation from — 30 to + 120 deg. and for corresponding total expansion and contraction movements of 5 and 6 in., respectively, including allowance for error of adjustment and for camber.

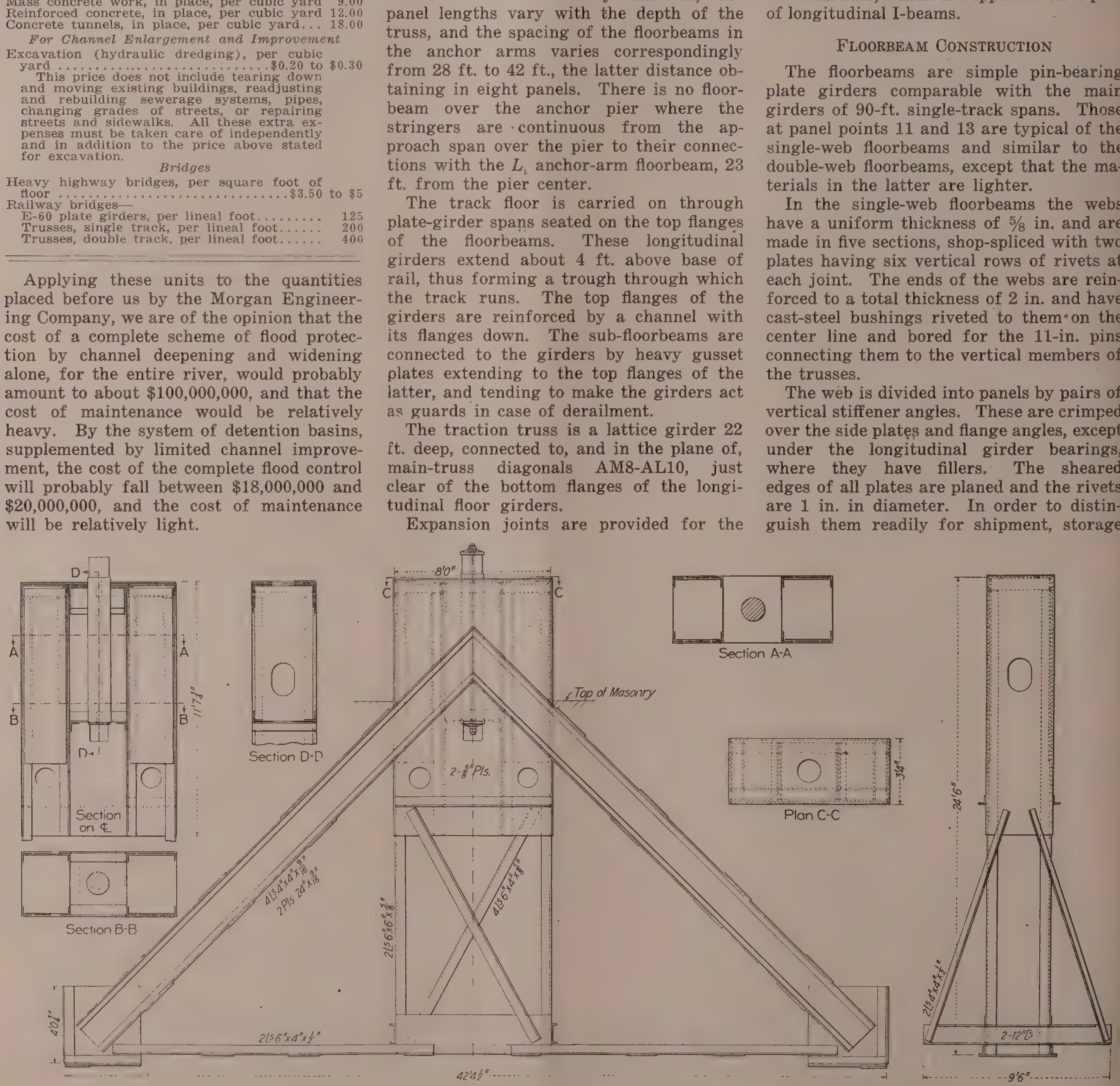
In the plane of each sub-floorbeam a solid-web cantilever bracket about 7 ft. long over all is web-connected to the outer face of the outer track girder to carry the concrete sidewalk slab, which is supported on a pair of longitudinal I-beams.

FLOORBEAM CONSTRUCTION

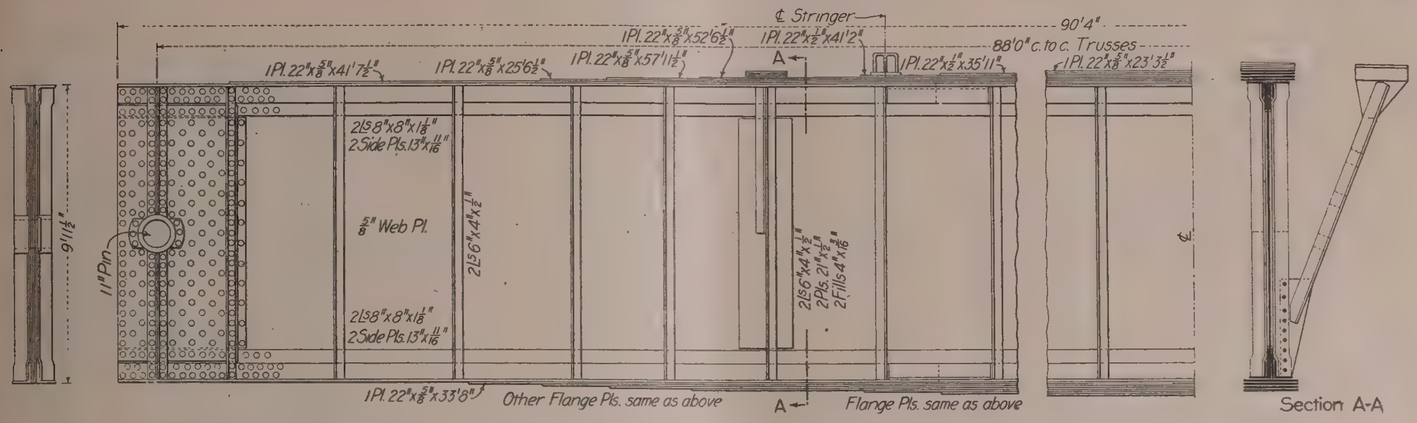
The floorbeams are simple pin-bearing plate girders comparable with the main girders of 90-ft. single-track spans. Those at panel points 11 and 13 are typical of the single-web floorbeams and similar to the double-web floorbeams, except that the materials in the latter are lighter.

In the single-web floorbeams the webs have a uniform thickness of ⅝ in. and are made in five sections, shop-spliced with two plates having six vertical rows of rivets at each joint. The ends of the webs are reinforced to a total thickness of 2 in. and have cast-steel bushings riveted to them on the center line and bored for the 11-in. pins connecting them to the vertical members of the trusses.

The web is divided into panels by pairs of vertical stiffener angles. These are crimped over the side plates and flange angles, except under the longitudinal girder bearings, where they have fillers. The sheared edges of all plates are planed and the rivets are 1 in. in diameter. In order to distinguish them readily for shipment, storage



RIVETED FRAMEWORK BUILT INTO ANCHOR PINS IN ORDER TO TRANSMIT WIND STRESSES TO MASONRY



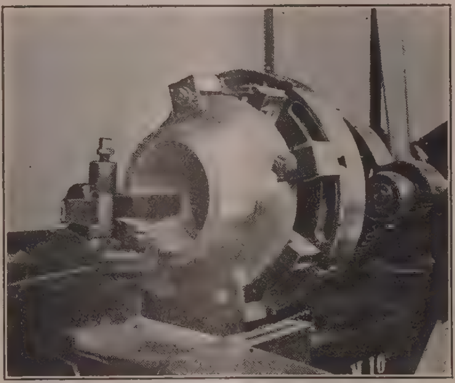
HALF ELEVATION AND CROSS-SECTION OF INTERMEDIATE FLOORBEAMS AF11-13 WITH PIN CONNECTIONS

and handling the shipping marks of members for the north-shore anchor arm are painted on in white and those for the south-shore arm in green.

The single-web end floor beams at panel point 1 have pairs of horizontal angles to receive the field-riveted connection plates for the lower lateral system. These floorbeams weigh 126,800 lb. each, while the other single-web floorbeams in the anchor arm vary from 94,600 to 110,300 lb., and the heaviest double-web floorbeams weigh 135,600 lb.

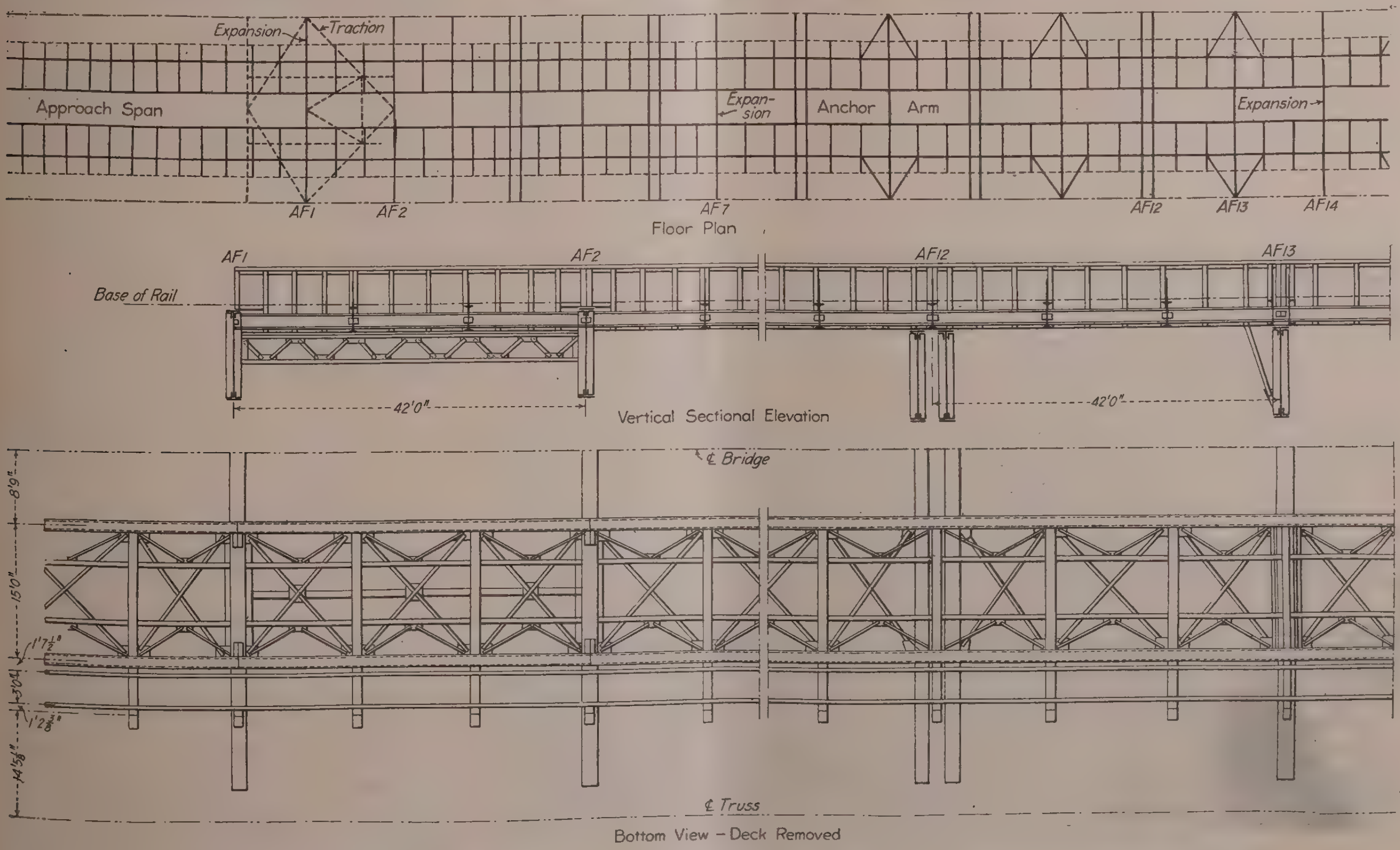
Owing to the fact that the end of the anchor arm of the Quebec Bridge is attached directly to the steel grillage in the anchor pier by long chains of eyebars, it has no stability, being free to move in any direction on the horizontal plane. On account of this fact some special arrangement had to be designed to take care of the transverse wind reaction from the bottom lateral system at this point, which amounts to 673,000 lb. In order to effect this a special wind anchorage has been designed, which consists of an A-frame embedded in the anchor pier, the apex of which extends slightly above the masonry. This A-frame supports a 14-in. pin 8 ft. 7½ in. long, which extends vertically 6 ft. through the apex.

The end members of the lateral system of the anchor arm meet at a point directly over this pin and are supported between the trusses by a heavy cross-strut. Special connections are made between the ends of the laterals and this pin, which allow for the longitudinal and vertical motions required by the changes in length of truss and anchorage eyebars due to temperature, but resist all transverse motion.



BORING FLOORBEAM PIN BEARING

GRASS AS A SOIL BINDER along the banks of large earthfills is discussed in the June issue of the "Iowa Service Bulletin." Among grasses developing a good system of roots, as well as possessing ability to withstand the hot rays of the sun, the following are termed the best: Hungarian brome grass, hairy brome grass, Canadian blue grass, Fescue grass and Western wheat grass. Quack grass is regarded as a weed. Western wheat grass has unusual ability to grow on the sunny side of an embankment and may, moreover, be easily killed by cultivation. Planting and seeding are said to be equally successful, and, where it is desired to plant, sweet clover and creeping honeysuckle are recommended. These are especially useful in cuts.



DIAGRAMS AND DIMENSIONS OF BEAMS, GIRDERS, STRINGERS AND BRACING IN ANCHOR-ARM FLOOR SYSTEM

Small Rapid Filter Plant at Port Clinton, Ohio

Three 500,000-Gallon Units with Non-Baffled Sedimentation Basins and Proportional Coagulant Feeder

NON-BAFFLED sedimentation basins, a proportional coagulant feeder and trouble with released air in an intake line are features in a rapid filter plant comprising three 500,000-gal. units, two coagulating basins of 70,000-gal. capacity each and a circular clear-water basin, put into service in December, 1911, at Port Clinton, Ohio, a town of 3000 people, on Lake Erie, 30 miles east of Toledo. The plant is located on park property, alongside the existing pumping station. In order to keep up the pleasing appearance of the park, the filter house is made a duplicate of the pumping station connecting the two buildings by a passageway in which were placed two 1,000,000-gal. low-lift direct-connected Worthington centrifugal pumps operated by Troy vertical engines. A wash-water pump having a rated capacity of 1400 gal. per minute, and a Roots No. 1 blower, were also located in this passage.

INTAKE TROUBLES

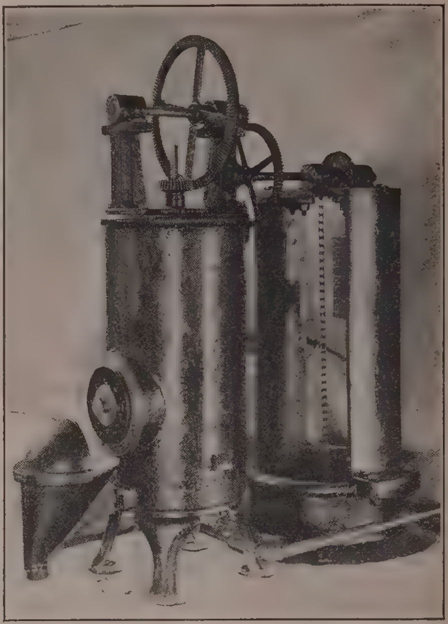
Port Clinton uses an average of 550,000 gal. of water per day, with 700,000 gal. as a maximum. Water is obtained through a 16-in. intake pipe extending under the Portage River into the lake, 2300 ft. from the pumping station. At this point the water is 16 ft. deep and continually stirred up by the waves, producing a light-colored, finely-divided turbidity. Some difficulty has been experienced with sand entering the intake valve which is placed on top of the end of a tee at the end of the intake pipe. Ordinarily the water enters through two swing flap-gates on the sides of a valve opening in. When it is desired to flush the sand out of line these valves close automatically, forcing the water and sand to escape through a flap gate on the top of the valve casting opening into a 6-in. pipe rising 8 ft. above the intake valve and terminating in an elbow which delivers the sand outside of the filter crib. To get to the intake valves water must go through a 12-ft. layer of gravel too coarse to exclude sand. A by-pass from the 14-in. force main provides flushing water through a suction line to a near-by slip.

For some time after the filter plant was put into operation it was thought that the intake pipe which had been in service for some years had accumulated a certain amount of sand, impossible to flush out. However, it was noted that during backflushing air bubbles issued from the end of the line, a circumstance leading to the surmise that air had collected in summits, although the pipe was supposed to have been laid on an even grade. Examination by soundings indicated such was not the case and as less than the full capacity of the pipe was ordinarily drawn through it, air released by the vacuum head collected at the summits and reduced the carrying capacity. Calculations of the theoretical loss checked with the 18-in. vacuum required less the normal friction and static head. On relaying the pipe to an even grade the vacuum dropped to 6 in., the theoretical suction lift.

NON-BAFFLED SETTLING BASINS

In the two coagulating basins which are 15 ft. 3 in. wide, 50 ft. long and 13 ft. deep, no baffles are used. Raw water is carried to the outer end by 12-in. tile pipe laid on concrete blocks on the floor. Here it enters a pipe laid parallel to the end of the basin. The discharge is at a 45-deg. angle, through four openings, upward and toward the 12-in. brick deflector wall, 3½ ft. high and 3 ft. from the back wall. This wall is corbelled out at the top to retard the velocity of the water and diffuse the flow. Bars were set in the back wall and it was the intention to anchor slats to them so as further to break up the velocity of the water. It was found unnecessary to provide these slats as in practice the water does not stream across the basin except at infrequent intervals. Settled water is collected at the filter end of both basins by a common channel through four 2-ft. openings provided with stop-plank grooves. For the purpose of cleaning the basins, the floors are pitched toward one corner, where a 12-in. blow-off valve is provided with an extension stem to a stand on the 6-in. roof.

Walls of the basins are 18 in. thick, of concrete reinforced for water pressure on the outside as well as on the inside.



PROPORTIONAL COAGULANT CONTROLLER

OPERATING GALLERY OF FILTER PLANT AT PORT CLINTON, OHIO

Aluminum sulphate, used as a coagulant, is mixed in two wooden tanks, 5 ft. in diameter and 6 ft. high, from which the solution flows by gravity to an automatic cast-iron controller where the head over an orifice is regulated through a float operated train of gears by the elevation of water over an orifice in the influent control chamber feeding the sedimentation basins, thus correlating the flow of chemical to the flow of raw water at the point where the solution is applied. A hard-rubber disk with various-sized orifices gives a large range for the coagulant application rate. The influent chamber orifice is a rectangular sliding-plate arrangement set by hand to a graduated scale.

FILTERS

Three reinforced-concrete filter tanks, 7½ ft. deep and having a sand area of 182 sq. ft., rest on the walls of a 60,000-gal. clearwell. There are also two 1 x 2-ft. posts under the center of each dividing wall. The underdrain system consists of filter strainers spaced on 6-in. centers, screwed into 2-in. cast-iron laterals, 6 in. center to center, leaded into the side of a single oval cast-iron manifold. The total area of the opening in the strainers is equivalent to 0.29 per cent of the area of the filter.

In the air system a 3-in. galvanized-iron pipe runs around three sides of the filter, just above a 6-in. layer of graded gravel supporting 30 in. of Cape May sand, having an effective size of 0.4 mm. and a uniformity coefficient of 1.5. One-half inch outside diameter brass pipes are screwed into the 3-in. headers at one side of the filter and slide into reamed holes in the pipe on the opposite side. The brass pipes are spaced on 6-in. centers and are drilled on the under side every 6 in. with 1/16-in. holes. Similarly spaced holes are drilled in the bottom of the galvanized-iron pipes.

To carry off the wash water which is applied at the rate of 12 in. per minute, vertical rise, two troughs extend the long way of the filter and discharge into a concrete gutter across the front end of the filter, formed by a concrete wall extending 1½ in. above the top of the wash troughs. All valves in the pipe gallery have extension stems to hand-operated wheel stands on the operating floor, which is level with the top of the filter walls.

Results of the operation of the plant indicate that on the average ¾ grain per gallon of coagulant must be used. Turbidities range from 10 to 400. Wash water is applied for 8 to 10 minutes. Air is used before the application of wash water for 2 to 3 minutes.

The designs were drawn and construction supervised by William G. Clark, consulting engineer of Toledo, Ohio. G. W. Doerzbach had the general contract at $22,332. The Pittsburgh Filter Manufacturing Company were sub-contractors for the filter equipment. The coagulant feed apparatus, loss-of-head gages, underdrain manifolds, strainers and rate controllers are their standard design.

Mortgagees of Machinery

Their Rights to Equipment in Use by a Failing Government Contractor, as Set Forth in a Recent Supreme Court Decision

By GEORGE A. KING
Of the Bar of Court of Claims, Washington, D. C

A DECISION of great importance to manufacturers or lessors of machinery used in carrying out Government contracts has recently been made by the Supreme Court of the United States in the case of the United States vs. Buffalo Pitts Company. This company sold a traction engine with its appurtenances to the Taylor-Moore Construction Company, delivered the same at Roswell, N. Mex., and took a chattel mortgage thereon to secure a payment of $1,600 of the purchase price. "The chattel mortgage conveyed the engine and appurtenances to the plaintiff on condition that if the mortgagor should fail to pay the sum of $1,600 according to certain notes or should attempt to dispose of or injure the property or remove the same from the County of Chaves, N. Mex., or if the mortgagor should not take proper care of the property, or if the mortgagee should at any time deem itself unsafe or insecure, then the whole amount unpaid should be considered immediately due and payable and it should be lawful for the mortgagee to take the property and remove the same and hold or sell it and all equity of redemption at public auction with notice as provided by law."

The mortgage was duly recorded May 22, 1905, and no part of the money thereby secured has ever been paid to the mortgagee, which has ever since been the owner and holder of the mortgage. The engine was put to work by the construction company upon the Hondo project of the Reclamation Service, which work was being prosecuted under a contract between the United States and the construction company.

GOVERNMENT SUCCEEDS CONTRACTOR

The construction company having made default in the performance of its contract on or about June 7, 1905, work was suspended thereunder and the construction company then assigned all its interest in the contract to the United States, which, pursuant to the contract, took possession of all material, supplies and equipment belonging to the construction company, including the engine and appurtenances.

On June 16, 1905, at Roswell, the plaintiff made a demand upon the defendant through Wendell M. Reed, district engineer of the Reclamation Service, for the possession of the engine and appurtenances, which the defendant then and there refused, and thereafter it retained and used the property in the work under the contract until June 21, 1906. Reed was the local representative of the Government in charge of the work under contract at and near Roswell, and as such took possession of the engine and appurtenances for the United States. Thereafter the defendant, by the director of the U. S. Geological Survey, to whom the Secretary of the Interior referred the matter, and by the chief engineer and assistant chief engineer of the Reclamation Service, ratified the acts of Reed. The mortgagor has never made any claim to the property since the suspension and assignment of the contract to the defendant.

SUIT INSTITUTED BY MORTGAGEE

The Government refused to deliver up the engine to the Buffalo Pitts Company. Although its officers stated that their attorney would recommend payment for it, a suit was instituted by the Buffalo Pitts Company to recover the amount of the chattel mortgage on the theory that this property was taken by the Government for public uses. The court said in the opinion, speaking through Mr. Justice Day:

"We think the Circuit Court and the Circuit Court of Appeals were right in concluding that under the facts found the United States was liable upon an implied contract. As to the plaintiff, it is specifically found that it left the property with the defendant, relying upon the fact that its title to the property under the mortgage was not disputed and upon the representations made to it, and consented to the defendant's retaining possession of the property in expectation of receiving compensation for it; as to the Government, it is found that it was well known to it that the chattel mortgage existed and its validity was undisputed, and that it would continue the use of the engine and appurtenances, and if left in its possession payment would be recommended for such use. . . .

GOVERNMENT'S OBLIGATION

"There is nothing to show that the Government expected to use the engine and appurtenances without compensation. It did not dispute the mortgage, and the findings of fact clearly show that if the Government had the right to take the property, notwithstanding the mortgage interest which the plaintiff had in it, it made no claim of right to take and use it without compensation as against the prior outstanding mortgage, which distinctly reserved the right to take and sell the property under the circumstances shown and which after the breach of condition vested the right of possession and the right to convert the property in the mortgagee. . . .

"Furthermore, the Government was authorized by Section 7 of the Act of June 17, 1902 (32 Stat. 388), under which this improvement was being made, to acquire any property necessary for the purpose and if need be to appropriate it. It may be said, as contended, that under the contract with the construction company the Government had a right to take possession of this engine which was in possession of the company as mortgagor and by virtue of the terms of the agreement complete the work, but it could not in this manner extinguish the rights of the mortgagee, nor did it undertake to do so. Under such circumstances we think the former decisions of this court, recognizing the general principles of justice which give rise to implied obligations, and enforcing the right of compensation when private property is taken for a public use, require the Government to make compensation for the use of this engine."

CONCLUSION

The conclusion was reached:

"The Government had the right to contract for this work under statutory authority and to acquire property necessary to that end. Under the contract it might take possession of the construction company's property, and, it may be conceded, finish the contract with such property, but it had no right to use the property of others without compensation, and in this case it did not assume to do so. The mortgagee had a distinct right in the property which had accrued to it before the property was entered upon, and was authorized to take and hold the same as against the attempted transfer of the mortgagor. While the Government claimed the right to thus take and use the property it nevertheless held it without denying the right of the owner to compensation. When it takes property under such circumstances for an authorized Governmental use it impliedly promises to pay therefor."

This decision is a most equitable one in sustaining the right of the owner of personal property taken by the Government and used in public construction work to recover its value under the constitutional provision guaranteeing to the citizen payment for private property taken for public use.

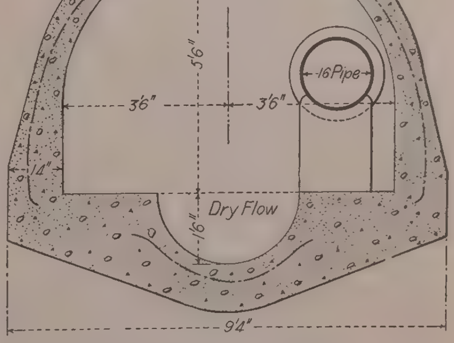
Water Main in Sewer

Provision for Carrying Pipe on Standards in 7-Foot Reinforced-Concrete Conduit

By STUART HOWARD
Major Civil Engineer, Sewer Department, Montreal

THE accompanying illustration shows a concrete sewer so constructed that the main water pipes can be placed in it on standards. The storm water which is admitted from portions of the city on the combined system does not rise very high in the sewer, the greater portion of the area served by this sewer being on the separate system.

The manholes are so constructed that the water pipes can be lowered into the sewer and placed on the standards. At the ground surface the manhole opening is 2 x 2 ft. 6 in., and at the crown of the sewer they are elongated so that the water pipes can be lowered at an angle to clear the walls.



WATER MAIN IN SEWER

Sewage Disinfection in Actual Practice

Observations Based on the Operation of Twenty Plants in the State of New Jersey Using Calcium Hypochlorite as a Disinfectant

By WILLIAM J. ORCHARD

Assistant Sanitary Engineer, New Jersey State Board of Health, Trenton

DURING the last six years the disinfection of sewage and sewage effluents as a practical form of sewage treatment has come to be adopted by a great many towns and municipalities. The growth of this form of treatment has been rapid, and present indications tend to show that its growth will be even more rapid in the future.

Much of the credit for the development of this process is due to Prof. Earle B. Phelps, now connected with the U. S. Public Health Service, who demonstrated in 1907 and 1908 that calcium hypochlorite was a practical and economical disinfecting agent as far as sewage and sewage effluents were concerned. Prof. Phelps carried on very extensive experiments at the Massachusetts Institute of Technology, Boston, at Red Bank, N. J., and at Baltimore, and the results of this work are very ably presented in Water Supply Paper 229 of the U. S. Geological Survey.

As a result of the pioneer work of Prof. Earle B. Phelps there are now twenty sewage-treatment plants in the State of New Jersey at which calcium hypochlorite is used as a disinfectant, and several more are under construction or planned. Of the plants in operation eighteen are for the disinfection of sewage that has received more or less preliminary sedimentation, one is for the disinfection of a contact-bed effluent, and one for the disinfection of the effluent from natural sand beds.

Some of these plants are visited by representatives of the New Jersey State Board of Health once a month and the others once every two or three months, so that every disinfection plant in the State is visited at least four times a year. A great many visits to these plants have led to the conclusion that in actual practice the disinfection of sewage presents difficulties not encountered in experimental work and probably not appreciated by the casual observer. These difficulties are not due to any inherent defect in the process but are directly attributable either to faulty design or to improper or unintelligent operation.

PURPOSE OF DISINFECTION

Sewage disinfection is resorted to generally as a practical and more or less economical means of preventing undue pollution of either water supplies, shellfish beds, or bathing beaches. If the disinfection is irregular and unreliable and does not destroy within the limits of practical disinfection the pathogenic bacteria in the sewage, the disinfection plant has fallen short of the purpose for which it was installed, and the consumers of the water, the shellfish, and the bathers at the beaches are unduly exposed to disease. That many of the disinfection plants at present in operation do fall short of the purpose for which they were installed is a regrettable fact.

Most of the trouble seems to be due to the shortsightedness of the designing engineer in not first experimenting with the sewage to be treated, and so designing the plant that the period of contact between the sewage or sewage effluent and the disinfecting agent will be sufficient to secure a reasonable bacterial reduction when a reasonable amount of disinfectant is used. Another reason for these plants not coming up to expectations is because as yet there has not been designed a dosing device that under actual working conditions is dependable and at the same time flexible enough to increase or decrease automatically the flow of hypochlorite solution as the flow of sewage increases or decreases.

PROPER PERIOD OF CONTACT

To illustrate these two points, a description of the conditions found to exist at a plant spoken of here as Plant A is given. At this plant the hypochlorite solution is added to sewage receiving such a short preliminary sedimentation that it might almost be spoken of as crude sewage. To this sewage it was planned to apply sufficient hypochlorite solution to secure a dose of 13 parts per million of available chlorine, and a short supplementary contact period was provided for. The purpose of applying the disinfectant was to protect shellfish and bathing beaches. The hypochlorite solution is applied through a patented device in which the dose depends upon the depth of immersion of a small rectangular orifice in a constant level dosing box. This depth of immersion increases with an increase in the amount of sewage arriving at the plant. The device is not dependable, however, because the orifice is so small that it becomes readily clogged by particles of undissolved bleach and by pieces of the scum or scale which sometimes forms on the surface of a tank of hypochlorite solution. At one visit it was found that the orifice became clogged six times within one hour, and until the clogging was removed the flow of hypochlorite solution ceased. Under these conditions it was determined that the dose of available chlorine instead of being 13 parts per million was 2.3 parts per million. By means of dye it was demonstrated that only 4½ min. elapsed from the time the disinfecting solution was applied to the sewage until the sewage was discharged through the outfall into the stream. At every visit B. coli by the presumptive test has been indicated in 0.001 cu. cm. of the discharged effluent and in some cases in 0.0001 cu. cm.

INSUFFICIENT OPERATING DIRECTIONS

At some plants much trouble is due to the designing engineer leaving the plant upon its completion without giving proper instructions regarding its operation. A case in point is Plant B, a relatively new plant embodying some commendable features of design. It is so arranged that the hypochlorite solution may be added to the sewage in its crude state, or after periods of sedimentation ranging from 1 to 4 hr. It is a very flexible installation, from which exceptionally good results can reasonably be expected.

The designing engineer left the plant upon its completion without giving directions regarding its operation. The local sewer committee appointed a member of the city police force as the attendant of the plant and he was required to visit the disinfection house twice a day, mix up the bleach solution and keep the pipes and orifices free from deposit. About six weeks after the plant was put into operation a representative of the State Board of Health visited it and found that the hypochlorite solution, instead of being added to the sewage, was flowing through a series of petcocks into a trough connecting the various sections of the sedimentation tank. The outlets from this trough were all tightly closed by stop-planks and the hypochlorite solution was simply storing up in the trough and absolutely no disinfection was accomplished. All of the bleach that had been used in the previous six weeks had been wasted.

MACHINERY IN DISINFECTION HOUSE

Another difficulty often encountered at disinfection plants is due to the designing engineer placing pumping machinery in the disinfection house, where it is exposed to the corrosive action of calcium hypochlorite fumes. Any article of iron or steel which comes in contact with these fumes rapidly disintegrates and in a relatively short time must be replaced. Conditions found at Plant C illustrate this point. This plant is an installation for applying hypochlorite solution to a sewage that has received very satisfactory sedimentation and was built to protect shellfish beds. There is a high and a low level sewer system, and the machinery for lifting the low-level sewage up into the sedimentation tanks was placed in the building in which the hypochlorite was stored, mixed and applied to the sewage. This machinery consisted of electric motors, gas engines, displacement pumps, air compressors, ejectors, etc.

The low-level system was not put into use until the plant had been running for more than a year, due to a broken trunk sewer under a stream. This sewer was repaired and the low-level sewage arrived at the plant. It was found, however, that the machinery could not be started, and an examination showed that every exposed part of each unit had corroded to an unbelievable extent. Even the leather belts had become so hardened that they split when bent, and in some cases gaskets, bushings and washers had entirely disintegrated. The low-level sewage was rapidly backing up throughout the system, however, and after a liberal application of oil the electric motors were started, with the result that they both were burned out. It was necessary to bypass the low-level sewage for several months before repairs could be made, and the machinery had to be housed in a separate building.

IGNORANCE OF PLANT ATTENDANTS

Lack of ability and knowledge on the part of the plant attendant is responsible for most of the troubles at disinfection plants. Municipal officials seem to have the idea that sewage disposal must be associated with dirt and stench and filth and that a common laborer is the man to take care of a plant.

The need of intelligent, trained attendants at all sewage-disposal plants is growing more apparent daily. Particularly is this so in the case of disinfection plants. At these plants a man must be on the job every day to mix the hypochlorite solution, clean the dosing apparatus, and keep the plant in working order. At a sewage-disposal plant of any other type a man might occasionally take a day off without seriously affecting the operation of the plant. At a disinfection plant, however, the least neglect always causes trouble, for either the hypochlorite solution will become exhausted or the dosing device will become clogged, and in either case disinfection ceases.

To illustrate the ignorance of plant attendants the following conditions found at plant D are described. Plant D is a disinfection plant installed for treating a sewage effluent which is discharged into a water supply that is filtered before it is distributed to the consumers. The necessary daily amount of calcium hypochlorite to be used was determined as 30 lb. The attendant was advised to mix the solution daily and keep a constant flow. A subsequent inspection showed that the attendant carefully weighed out 30 lb. of hypochlorite every morning and dumped it into the mixing tanks. He then opened a spigot to fill the tank and at the same time opened the outlet. Water was allowed to run into the tank continuously, with the result that the bleach was soon dissolved. In the early morning the dose of disinfectant applied to the sewage was excessive, but it gradually reduced throughout the day until in the afternoon it was negligible. Tests made at noon showed B. coli to be present in 0.01 cu. cm. of the final effluent.

POLITICS AND SEWAGE

To further illustrate the carelessness of plant attendants and the effect of municipal politics upon the operation of sewage-disinfection plants a description is given of conditions found at plant E.

This plant was installed to protect shellfish beds, and the hypochlorite solution is added to a well-clarified sewage effluent. At the time the plant was put in operation the superintendent of sewers was not a trained man and he assigned a street laborer as the plant attendant. He was allowed 1 hr. in the morning and 1 hr. in the evening to visit the disinfection house and mix up the hypochlorite solution. The flow of this solution is controlled by hand-regulated petcocks.

Shortly after the plant was put into operation an inspection was made, and it was found that the hypochlorite solution was all allowed to run out in a few hours and that for the remainder of the day no disinfectant was added to the sewage. At one visit it was found that the dose of available chlorine was 11 parts per million for 13 hr., but that for the remaining 11 hr. of the day no hypochlorite solution was applied. While these conditions existed weekly inspections were made, but the importance of the matter was not appreciated by the superintendent and he refused to have the attendant take sufficient time to adjust the flow of hypochlorite properly. At many visits B. coli was found to be present in 0.00001 cu. cm. of the final effluent.

These unsatisfactory conditions continued for a few months and then a political upheaval occurred and a new superintendent of sewers was appointed. This man was a trained sanitarian who appreciated the importance of sewage disposal, and the operation of plant E under his supervision was greatly improved. The same laborer was instructed regarding the operation of the plant and was required to spend his entire time taking care of it. The dose of hypochlorite was regulated and the effluent was much more satisfactory. These better conditions continued for a year and then another political change occurred, the sanitarian was discharged and a new superintendent of sewers was appointed. He was not a trained man and took the same attitude as the sanitarian's predecessor, with the result that as far as the State Board of Health was concerned the work of securing proper operation had to be done all over again. At the last three inspections the dose of available chlorine has been 6, 2.3, and 4 parts per million, and in two cases B. coli was present in 0.0001 cu. cm. of the final effluent, and in one case in 0.00001 cu. cm.

IRRESPONSIBILITY OF ATTENDANTS

Another matter which enters into the operation of disinfection plants is the utter lack of appreciation of moral responsibility on the part of those in charge of the plant. For instance, plant F is an installation for disinfecting a contact-bed effluent. The final effluent is discharged into a relatively small stream, and 2 mi. below the outfall is the intake of a water supply, which receives no treatment whatever. This is clearly a case where those in charge of the disinfection plant are morally required to exert their best efforts to protect the consumers of the water into which the effluent discharges. Repeated inspections have been made, however, when it has been found that absolutely no hypochlorite was being applied and B. coli was present in 0.001 cu. cm. of the final effluent. The superintendent of the plant has absolutely disregarded the requests and orders of the State Board of Health, and legal steps have been taken to compel him to operate the plant so that a satisfactorily purified effluent will be discharged. The process of the law is so slow, however, that a water-borne epidemic may break out in the town before the necessary legal steps have been taken. If such an epidemic should occur the negligent superindent would certainly be morally responsible.

The cases cited are only typical of the general condition of disinfection plants. Almost every plant might be here described and used to illustrate some points of defective design or operation. George W. Fuller in the concluding paragraph of his book, "Sewage Disposal," says: . . . "If increased faithfulness is not given to the proper operation of sewage-disposal works it is only a question of time when steps should and will be taken by the State authorities in the more thickly populated sections of the county to make compulsory the proper management of sewage-disposal works."

CENTRAL SUPERVISING AUTHORITY

With disinfection plants it surely is only a question of time, and the day probably is not far distant when the central supervising authority will be given more power to secure the discharge of a proper effluent and more workable laws to enforce this power. When this power is secured it will probably be necessary to adopt standards which the effluents must measure up to before discharging.

The adoption of such standards presents many obvious difficulties. As a basis of comparison the presence of B. coli in definite quantities of the effluent will probably be used, and the standard will be expressed as not more than a certain number of B. coli in a liter. If such a method is adopted no arbitrary standard could apply to every disinfection plant, and each case would have to be studied and a standard adopted in harmony with the controlling factors.

Among factors which should be considered in the case of an effluent discharging into a water supply might be mentioned the normal dilution afforded by the stream, the distance of the outfall from a water intake, and the measures taken to purify the water supply.

In the case of a disinfection plant discharging an effluent into waters near shellfish beds it will be necessary, before standards are adopted, to determine the dilution factor and consider the stream or ocean currents tending to carry the sewage effluent to the shellfish areas. In the case of oyster beds, if the hibernation theory is accepted it will be necessary in every case to determine what allowance should be made during the season of hibernation, and when this season begins and ends.

The whole matter of adopting standards for the effluents from sewage-disinfection plants is one that will probably not be developed for some time in the future. Until such standards are adopted, however, and more power is given to the State authorities intelligent supervision of sewage-disinfection plants will be a very difficult and discouraging problem. If designing engineers will recognize the difficulties encountered in operation and make their plans accordingly, and if the plant attendants will appreciate their moral responsibility much can be done to improve the present practice in sewage disinfection.

Quick Work in Foundation Excavation under Difficulties

How a Contractor Escaped a Penalty of $400 per Day in Preparing for the Substructure of a Los Angeles Building

A CONTRACT was recently awarded for the excavation of about 15,000 cu. yd. of material in preparing for a building foundation at the corner of Fifth and Spring Streets, Los Angeles. The work was to be finished and foundation concrete ready for steel by July 1, the stipulation being that a penalty of $400 per day would be forfeited for each additional day needed to complete the job. The use of the usual economical methods of excavation was made impossible by local conditions, and unforeseen difficulties placed additional obstacles in the way of timely completion. However, the last concrete was poured shortly after 11 o'clock on the night preceding the day on which the first penalty could be imposed.

The excavation was 154 x 115 ft. in plan, about half of which was to be sub-basement with a floor 30 ft. below street level, and with column footings 10 ft. deeper. Included in the contract were the satisfactory shoring up of a building on an adjoining lot and the putting of new foundations under it extending to a depth of 40 ft. below street level. A portion of the area was turned over to the contractor on April 28, but owing to the nearness of adjacent buildings it was impracticable to use a steam shovel, and a stiffleg derrick operating a 2-cu. yd. skip was installed. A 30-cu. yd. bunker, built over the sidewalk, was arranged to discharge into auto trucks standing in the street, so that the work was carried on without blocking traffic. The rate of excavation was about 600 cu. yd. per 24 hr., and six auto trucks handled this quantity satisfactorily.

At 10 a. m. June 7 the contractor got

possession of the remaining portion of the area, on which stood a two-story brick building 30 x 80 ft. in plan and a single-story brick structure 40 x 75 ft. in plan. By 8 a. m. June 8 both of these structures had been wrecked and removed and the excavation was then commenced.

The method of supporting the adjacent building was to excavate 6 x 6-ft. wells 40 ft. deep beneath its foundation, and carry up in each of these a section of a suitable foundation wall, leaving toothed edges for joining with adjacent sections. Eighteen such wells were required and 275,000 bricks were used in placing a continuous wall under the old foundation.

Another feature of the work was the sinking of the forty piers for column footings. Where these were located in the basement near the sub-basement wall it was necessary to carry them down to the full depth of 40 ft. below street level. This entailed excavating a 6 x 6-ft. well in order that a footing of this size could be placed, and after a 3-ft. column had been built up to basement level on this footing the remaining space was filled in again with part of the material excavated.

The sidewalks passing along the edge of the basement and sub-basement excavations had to be shored up, of course, without interfering with the pouring of concrete in the retaining walls. In order not to have to remove from the job the material excavated for these retaining walls an amount of earth equivalent to the estimated volume of this material was taken from below the basement floor level, and when the earth was removed to make way for the retaining walls it was used to fill up this central "borrow pit."

The walls and column footings required a total of 3000 cu. yd. of concrete and 75 tons of reinforcing steel. The work was done by the Sound Construction Company, of Seattle, Wash., under the personal supervision of J. T. Walsh, engineer and manager.

MORE STEAM by 15 per cent without any special effort to force boilers was obtained by chain-grate stokers than with hand firing at St. Louis waterworks. There is also a gain of 18 per cent in efficiency in the test runs at the 350-hp sanitarium power-house plant, where the boiler-grate and furnace efficiency reached 69 per cent.

FINISHED TERRYVILLE PAVEMENT COVERED WITH EARTH TO CURE

Connecticut's Concrete Roads

Twenty-two Miles of One-Course Pavement, Principally Without Bituminous Covering, Will Be Completed at End of 1914

BECAUSE of the general attention that has been focused upon the several notable areas of concrete pavements laid within the last five years in some of the Middle Western States, less notice has been taken of the constructive work in investigating this type of work done by some of the Eastern State highway departments. In Connecticut, for example, during 1913 and the season now under way contracts for about 22 mi. of single-course concrete road have been awarded. These are not to be found in one small section, as in the case of the Wayne County (Michigan) system, but are distributed in short stretches over a large part of the State.

A conservative sentiment with regard to this type of road characterizes the State Highway Department. Commissioner C. J. Bennett, though firmly believing that the road will be an economical one, has stated that the State's brief experience with this type does not warrant any radical claim for long life. His position is rather that a well-laid single-course road may be used for about five years. At the end of that time, should the surface wear warrant it, the pavement may be used as a foundation for a block pavement, or it may be given a bituminous covering. This means that at a reasonable first cost a road may be used with minimum maintenance expense for half a decade, continuing a useful life after that period in supporting another surface.

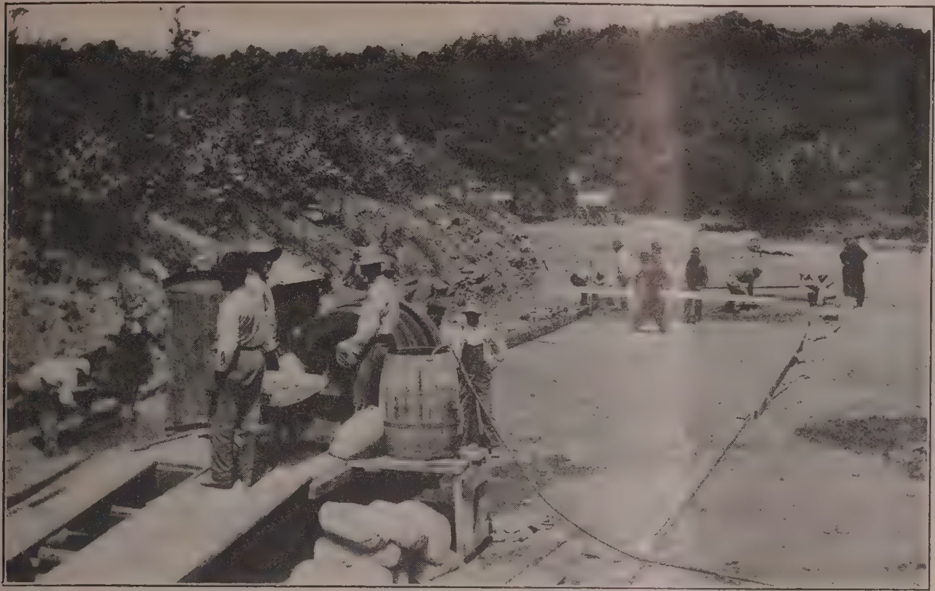
Connecticut Practice

A résumé of the roads laid during the past two years under this prospectus discloses much that is standard practice and a few rather unusual points. Practically all of the work is of a 1:2:4 mixture, trap rock, of which there is an abundance in the State, being used in most instances as coarse aggregate. However, very good gravel is usually found where trap rock is hard to get. When the product of the gravel bank is not of the right grading to make screening advisable, the contractor is recommended to introduce crushed stone. Insistence upon standard materials is a watchword in the department, as lack of uniformity has been found even in the cement. This spring a peculiar property was discovered in a local sand, which responded satisfactorily to all the usual tests but greatly retarded the setting of concrete made with it. After the engineer had thrown away the defective mixture, however, it was found to have taken a tough, permanent set at the roadside.

It is customary frequently to check the proportions of sand and stone going to the concrete with calibrated boxes. The finished road surface is covered with earth and kept wet for at least seven days before traffic is allowed upon it. Adverse weather conditions increase this time, however, and in the late summer and early fall it has been extended to three weeks in some cases. In no instance has trouble resulted from letting traffic on the road too soon.

Highway officials in the State are thoroughly satisfied with the performance of

SAYBROOK TURNPIKE—BROOMED SURFACE IN FOREGROUND, EARTH-CURING AT REAR



BUILDING TERRYVILLE ROAD—FIRST CONCRETE HIGHWAY IN CONNECTICUT

tar-paper joints, though in a few cases a metal-protected joint has been used as well. The practice is to cut the tar paper off about ¼ in. above the surface, letting traffic grind it into the edges of the joint. The successful use of this material instead of the metal joint means a 5-per cent reduction in the cost of the road—a strong argument in its favor.

The accompanying table gives the principal data concerning the roads. The ½-mi. stretch at Plymouth, known as the Terryville Road, was the first concrete section laid in the State. The slab is flat-bottomed, 5 in. thick at the side and 7 in. at the center, giving a ¼-in. crown. The joints, placed, as is usual, every 25 ft., are left ⅜ in. wide and filled with tar paper. The edges are protected with Baker armored plates. The location is between the Pequabuck River and a steep hill rising at points 55 ft. above the road surface—a difficult alignment involving the removal of 10,000 cu. yd. of sand and the construction of concrete retaining walls to support the slope. The shoulders of this road are of trap rock, to support a heavy steel-shod traffic.

STATISTICS OF CONCRETE ROADS IN CONNECTICUT

Description	Total length, ft.	Width, ft.	Cost per square yard	Remarks*
E. Haven-Branford ..	2,786	21	.....	Partly reinforced.
Branford Hills..	6,332	18	$1.66	Max. grade, 8 per cent.
Meriden-Cheshire (South Meriden)	6,555	14-16	.89	
Saybrook Turnpike (Middletown)	5,469	16	1.43	
Terryville Plymouth ..	3,150	16	1.31	Metal plates and tar paper at joints.
Ridgefield-Branchville.	6,680	12	1.38¾	1944 ft. of 1:2:3 mix.
Wallingford ...	6,900	32	1.50	Hassamite; no joints.
Park St. (Hartford)	6,418	14	1.58	
Watertown (Waterbury).	3,500	16	1.13	
East Hartford..	4,500	41	1.20	Hassamite; no joints.
New Haven Turnpike (Milford)	8,407	14	1.19	Reinforced.
Cheshire	6,950	18	1.07	
Seymour	4,418	16	1.30	Hassamite; no joints.
Willimantic (Windham) .	3,449	16	.68	
Milford Turnpike (Orange)	22,652	16	1.12	Reinforced.
Springfield (Windsor) ..	15,485	18	1.33	
Hamden	3,675	35	.95	

*Unless noted in this column, all slabs are 25 ft. long, of 1:2:4 mixture, non-reinforced, with only tar paper at expansion joints. The usual thickness is 6 in. All have been built since 1912.

On the Saybrook Turnpike, running out of Middletown, which is the second concrete road built in the State, many of the curves have been banked. The efficiency of this innovation is shown in the statement that the traffic is 90 per cent automobile. The required superelevation for the various curves was determined by running a pleasure car at the assumed standard rate of speed around the turn, a cut-and-try method which proved very successful. The practice is being continued at other points, elevations varying from 6 to 14 in. being made use of, the greater where the country is least settled.

The cost per square yard of the Branford Hills road, $1.66, included that of gravel shoulders and drains, which were laid 3 ft. under the edges of the concrete. Red clay underlies this road for the greater part of the distance. The road bears a heavy traffic and has a maximum grade of 8 per cent.

Like the Terryville road, the Ridgefield-Branchville road has a cross-section 5 in. thick at the side and 7 in. at the center. The Hassamite pavement at Wallingford was built in 1913. This road has an exceptional width—32 ft.—and was laid without joints. Cracks have now opened up from 40 to 60 ft. apart and the surface has been covered with a thin bituminous mat. Two other sections of this patent pavement are now being constructed—in East Hartford and Seymour, both being laid without joints.

Several sections of the system have been reinforced, mostly for experimental purposes, but in some instances to counteract the effect of an inferior foundation. These sections are on the East Haven-Branford road, the New Haven Turnpike in the town of Milford, and the Milford Turnpike in the town of Orange. The reinforcement is placed 2 in. below the top of the slab and has the standard 0.038 and 0.049-sq. in. sections, the greater being taken at right angles to the center line of the road.

GENERAL COST DATA

The lowest price at which any of these roads has been let is 68 cents for one awarded this spring at Willimantic in the town of Windham. The Meriden road, built in 1913, however, cost only 89 cents per square yard. Additional work under an amended price was done on the East Haven-Branford road, and the true unit price is not at present available.

At the end of this season the length of the system will be about 117,000 lin. ft., and the total amount expended will be about $300,000. Using these figures and the various widths, a unit cost of approximately $1.16 per square yard is obtained.

ERIE, PA., metered 31.3 per cent of the water consumed in 1913, which amounted to 144 gal. per capita for the 80,000 people served through 18,091 taps. Bacteria, according to the annual waterworks report, in water treated with 7.35 lb. per million gallons averaged 37 per cubic centimeter with maximum and minimum months of 60 and 18. Odor gave trouble only once, and that due to chilled water in December causing a slow reaction. The turbidity of the water settled one and one-half days varied in monthly averages from 4 to 33 parts per million, a removal of from 20 to 46.6 per cent.

WIDE INTERSECTION ON PARK STREET, HARTFORD, SHOWING TAR-PAPER JOINTS

INTERIOR VIEW OF WHARF HOUSE, SHOWING TELPHER SYSTEM AND LIFT DOORS

Operation of Kansas City Municipal Wharf

Combined Use of Locomotive Crane and Telpher System, in Which the Former Has Been Highly Successful and the Latter Quite the Reverse

By CLARK R. MANDIGO
Assoc. M. Am. Soc. C. E.; Assistant City Engineer, Kansas City, Mo.

REVIVAL of navigation on the Missouri River, to relieve Kansas City from excessive railroad rates determined by rail competition only, has been accomplished by the establishing of a new boat line controlled by the Commercial Club of Kansas City and the erection of a municipal wharf. In the design of the wharf cheap handling of freight was the objective. The resultant plant consists of a long open quay, the full area of which is reached by a locomotive crane, and on the shore side a shorter shed with a continuous line of lift doors on each side, a roadway on the far side, and a double-track telpher system within. The crane has answered all requirements, and another will probably be installed when needed. The telpher system has not proved adaptable, and is used only for very heavy or bulky articles. In a redesign it would not be installed, the crane being relied upon to deposit the package at the proper door and trucks being used to take it into the building.

The Kansas City-Missouri River Navigation Company, which operates the boat service, has a capitalization of $1,200,000 preferred and $2,000 in common stock, the latter, carrying all the voting power, being owned equally by ten men elected by the Commercial Club. The Kansas City terminal, built by the city from the proceeds of a $75,000 bond issue, was finished in 1911.

The wharf, which is situated at the foot of Main Street, is a pile and timber structure about 550 ft. long. Running its full length, as the plan shows, is a track of 8-ft. gage for the electric locomotive crane. The wharf house is 306 x 40 ft. and is a one-story building of fireproof construction. In it are two telpher tracks, the arrangement of which is clearly shown in the plan. As one of the photographs shows, the sides of the building are made up of a continuous line of lift doors, separated only by the columns supporting the roof, which are 18 ft. on centers.

A railway switch track has been built along the rear face of the wharf not taken up by the wharf house, and a wide area on the wagon side of the house and the rear of the wharf has been paved with concrete. A macadam road has recently been completed connecting the wharf by low grades around the foot of the bluffs overlooking the river to the "West Bottoms"—the freight, stockyards and implement district of Kansas City. This is to avoid a 10 per cent grade on Main Street to the south, which requires the use of a snatch team when freight is being hauled.

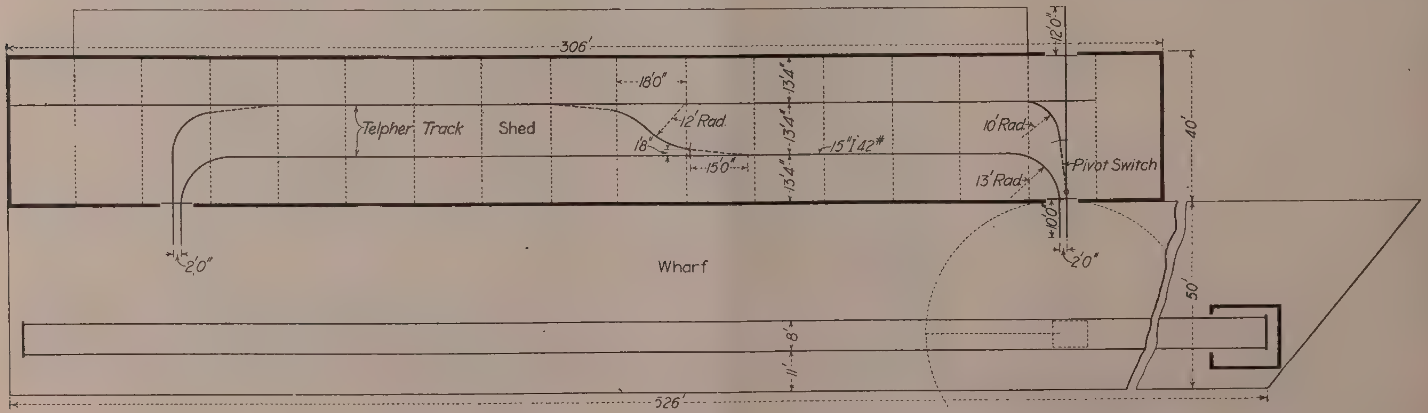
In connection with the construction of the wharf and wharf house a mechanical freight-handling system was worked out to reduce the excessive terminal charges which usually obtain for unloading and loading freight. The boat line is being operated between Kansas City and St. Louis, and this short haul (409 miles by water) makes the terminal cost a large proportion of the total cost of transportation. The freight-handling system had to be designed to care for all kinds of miscellaneous package freight, permit extension and enlargement as business increased, allow operation at low cost, minimize manual labor and be flexible, safe and speedy. These conditions are similar to those existing at a general railway freight station, but are not usual at wharves and docks where freight-handling development has been along the lines of cargo shipments of bulk material like coal, ore and grain. The system finally selected consists of a light electric locomotive crane which lifts a pack of freight from the hold of barge or boat, swings it to any point on the wharf, or to a position under one of the telpher tracks, whence it can be picked up and carried by the telpher to its proper position in the wharf house and stacked before the door assigned to the consignee, ready to be loaded into a wagon with a minimum amount of trucking.

LOCOMOTIVE CRANE

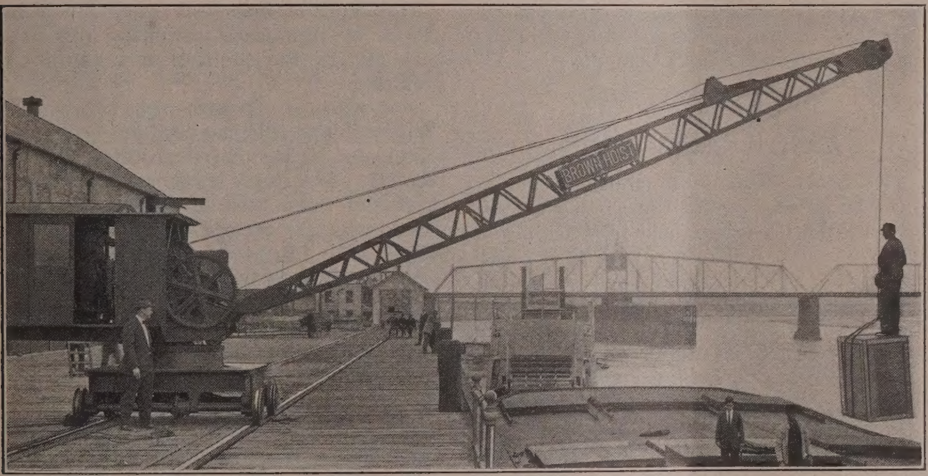
The electric locomotive crane is specially designed to meet the requirements of large radius of action, maximum capacity and speed with minimum floor loads. The maximum radius of action is 35 ft., which allows a swing of 20 ft. over the water and reaches the rear face of the wharf, and the rated capacity at this radius of action is 1500 lb. At the minimum radius of 17 ft. the capacity is 4200 lb., but in actual practice these capacities have been exceeded 25 per cent with safety.

The crane is operated by one 80-hp, 220-volt direct-current motor controlling the operations of longitudinal travel, boom swing, boom raising and lifting through friction clutches and gears off the driving shaft of the motor—all of which operations can be performed simultaneously. The lifting speed at full load is 250 ft. per minute and the boom can be swung six complete revolutions in a minute. The contract for the crane was let to the Brown Hoisting Machinery Company, of Cleveland, on specifications drawn by the city engineer's office and supplemented by the bidder's detail drawings and description.

The telpher track consists of 15-in. 42-lb. I-beams, so cut that joints come under supports only. There are only enough switches to make the system flexible and allow the telpher to be routed to different parts of the building. It is not necessary to throw a switch for each passage of the



PLAN OF WHARF AND HOUSE, SHOWING CRANE TRACK, SWEEP OF CRANE AND ARRANGEMENT OF TELPHER SYSTEM telpher even if two are working from the same doorway. The switches may be operated from the floor of the house by means of a cord attached to a bell-crank lever, or they may be thrown by the man in the telpher when approaching the switch from either direction. The crossover in the center is interconnected so that both switches are thrown in one operation. The tongue of each switch is attached to the main track by a heavy cast-steel hinge bolted to the upper flanges of the I-beams. At the other end the tongue is suported by a heavy steel casting carrying a broad wheel rolling on the curved steel angle riveted to the upper flanges of the two connecting I-beam tracks. This makes a switch which is much more easily operated than a sliding contact switch. The switch inside the door on the west end is supported by a heavy cast-steel pivot, as a hinge was not practical on account of the cantilever extending outside the doorway.



LOCOMOTIVE CRANE HANDLING FREIGHT BETWEEN BARGE AND WHARF HOUSE

The telpher is electrically operated by two motors controlled from an open cage attached to the machine; it has a lifting capacity of 3 tons, with a hoisting speed of 25 ft. per minute and a traveling speed of 250 ft. per minute when fully loaded. The maximum lift of hook is 20 ft. The machine is provided with an automatic switch and electric brake, which cuts out the hoisting motor and clamps the drum at the extreme upward position of the hook. The telpher is supported from two cast-steel trucks of four wheels each, the wheels on one truck being geared to the travel motor which sets below them. Between the frames of the trucks is swung the hoisting drum. The details of the switches and the telpher were worked up by the Modern Steel Company, of Waukesha, Wis., who had the subcontract for the steelwork on the building, and submitted to the engineer for his approval before proceeding with their manufacture.

Costs

Costs of wharf, house and equipment were as given in the table. There is left more than $4,000 unspent from the original $75,000 bond issue, which may be used for further equipment.

Control of the municipal wharf is in the hands of the Board of Public Works. Companies using the wharf or wharf house for freight are required to furnish at their own expense competent men to operate the crane and the telpher, or pay the city for the hire of these men, pay for all electricity used by themselves and for repairs due to carelessness, and, in addition, pay the nominal sum of 2½ cents per ton for all freight handled over the wharf and 2½ cents per ton additional for all freight handled through the wharf house, the rate to apply to both incoming and outgoing freight. In addition all steamboats docking at the wharf pay $5 and barges $3 as a wharfage charge.

Comment on Systems

In the equipment and operation of the municipal wharf the problems to be solved were in many ways entirely new to river navigation in this country. Consequently only enough has been done to make an operative system which can be enlarged or added to as necessity demands. The wharf and building may readily be extended and the main columns are heavy enough to support a second story by placing a row of columns down the center of the building on the first floor.

The physical limitations along the Kansas City waterfront, the great fluctuations in the river stages, the miscellaneous character of the high class of freight handled and the limited amount of funds available all made demands which have proved hard to meet in a completely satisfactory manner. The writer, who designed the entire layout for the Kansas City Terminal, must be the first to admit that in some respects the freight-handling equipment has not been as successful as anticipated. The telpher system in the wharf house has proved unsatisfactory. It was at first proposed to ship small package freight in large wood or steel crates directly from consignor to consignee so as to eliminate considerable labor in handling. The telpher was designed, therefore, to handle loads of 3 tons. A telpher arrangement designed for loads of from 1500 to 2000 lb., running on crane rails instead of directly on the flange of an I-beam, and operated by cords from the floor, would probably be an improvement on the present system. Such a system would not, however, be installed on a re-design, as it has proved much better to have the crane deposit the boxes in front of one of the numerous doors of the wharf house, where they are quickly trucked inside the building, a distance of from 10 to 40 ft. The telpher has only proved useful in handling very heavy or bulky articles.

Costs to Date of Wharf, House and Equipment

Wharf complete, excluding track and shed for crane	$23,760.00
Wharf house, including telpher and telpher track	30,180.98
Crane track and shed (except electric wiring)	2,450.00
Electric locomotive crane	4,165.00
Electric lighting and trolley wire for crane	896.00
Concrete paving on team side	3,563.31
Macadam road to connect with "West Bottoms"	5,100.00
Miscellaneous	312.53
Total to date	$70,427.82

Success of Crane

The electric locomotive crane, on the other hand, has answered all requirements, and another one will probably be installed as soon as freight increase demands it. A continuous chain or belt conveyor will probably be placed this coming season on one of the inclines in the wharf to take care of the small package freight from the boat or barge to the door of the wharf house. A conveyor of this type has been in operation the past year at St. Louis and has proved very satisfactory and offers attractive possibilities in speed and flexibility. The wharf itself might well be narrowed to 35 ft. and the saving thus made used as additional length. The present 50-ft. width does not appear necessary for the handling or storage of freight. Material can easily be stacked by means of the crane, so that so much floor space is not necessary opposite each barge.

Other details have worked out very nicely. The average cost of unloading freight from barges and stacking in the wharf house has been reduced from 90 cents per ton, the cost when negro roustabouts only were employed, to 30 or 35 cents per ton with the electrical equipment. At present smaller and lighter packages are handled by the crane in large rope nets.

Time Tests

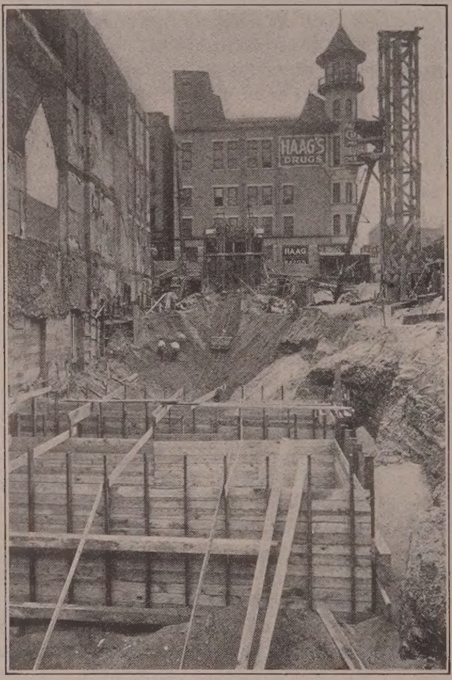
Several timed tests have been made on the speed of the mechanical handling of freight. On one occasion thirty-eight boxed pianos were taken from the hold of a barge and deposited in the wharf house in thirty-eight minutes. At another time the crane averaged a lift per minute, of an average weight of 1200 lb., for two hours. A boat of 156 tons of miscellaneous freight was unloaded at the wharf in nine and one-half hours, and a barge of 300 tons of miscellaneous package freight was unloaded in twenty-two hours with the new equipment. Eleven men handle all the freight unloading where formerly thirty men were necessary, and the eleven accomplish considerably more in the same time.

Those who are familiar with the idiosyncrasies of the Missouri River—its fluctuating level, its shifting sand bars and channels—will appreciate the difficulties to be met in establishing a freight-carrying boat line. The shipper demands regularity and dispatch as well as safety and careful handling. The continual improvement of the river channel by the Government looking to a permanent 6-ft. channel within the next ten years, the enlargement and improvement of the terminal facilities as necessity arises, the large capital and more especially the progressive business-like methods, acumen, energy and fighting spirit back of the Kansas City-Missouri River Navigation Company will undoubtedly overcome all difficulties so far encountered and make it a successful enterprise to which other cities on our inland waterways may well look as an example.

Power Scraper for Basement Excavation

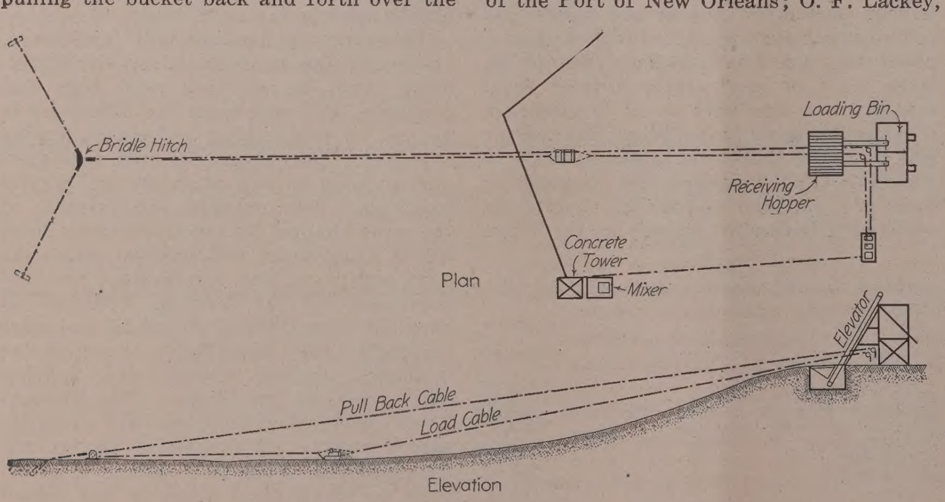
Handling Material by Machinery in the Business Center of a City

EXCAVATING the basement for the new office building of the Occidental Realty Company, in the business center of Indianapolis, was carried out by using a power scraper which handled 12,000 yd. of gravel in eighteen days from an area of 70 x 200 ft. As installed the equipment consisted of a Sauerman ¾-yd. scraper with pull and tail ropes, a three-drum, 75-hp Thomas electric hoist, receiving hopper, two Link-Belt bucket elevators and two loading bins located as shown in the drawing.



POWER SCRAPER HAULING MATERIAL

The bottomless patented scraper bucket has a hinged plate bolted to the lower side and back end of each side plate, with a cutter edge mounted on a runner frame. The cutter edge is adjustable and pivoted so as to adjust it to different soils. When the empty bucket is pulled back by the "pull-back" cable, the runner frame and cutter edge are dropped and the runner frame then forms a sled for the empty bucket to travel on. Operation consists of pulling the bucket back and forth over the material to be excavated, loading being completed automatically by the construction of the back of the bucket, which prevents the cutter edge from sinking into the material after the bucket is filled.



ARRANGEMENT OF CABLES AND PLANT FOR SCAPER-BUCKET BASEMENT EXCAVATION

Operation

As operated in this excavation a head-and-tail block served as a guide for the tail cable leading from the rear drum of the hoist to the rear of the excavator. The pull cable led from the front drum through a head guide block to the front of the bucket.

The third drum on the hoist was used to operate the Insley concrete hoist, which was located near the center of one side of the excavation. Concrete, mixed in the Milwaukee mixer, was chuted into shoring foundations of adjacent buildings over the excavating operations and simultaneous with them.

Forty-two teams were employed to haul the material away. Labor and other expenses amounted approximately to $20 per day. The excavation was carried out by the H. W. Klausman Engineering Company for the Occidental Realty Company.

Book Reviews

Two books have been published dealing with the proceedings of the Fifth National Conservation Congress held in Washington last November. One of them treats of water power subjects exclusively and is an important contribution to constructive literature on this subject. The other contains the forestry reports and addresses, which were conceded to be the most valuable ever presented at a similar meeting in this country. (N. C. McLoud, Treasurer and Recording Secretary, Swetland Building, Cleveland. $1 each.)

The "Proceedings and Papers" of the second meeting, held Dec. 9-11, 1913, at New Orleans, of the National Association of Port Authorities have been published in a 203-page paper-covered volume. In addition to the account of the meeting, the names of officers and the constitution of the association, the book contains the twelve formal convention papers. These treat of port development and administration in various phases, and include several technical papers. The authors of the papers are Calvin Tomkins, formerly commissioner of docks and ferries, New York City; W. A. Kernaghan, formerly president, Board of Commissioners of the Port of New Orleans; O. F. Lackey, harbor engineer, Baltimore; J. F. Coleman, consulting engineer, New Orleans; G. W. Norris, director, Department of Wharves, Docks and Ferries, Philadelphia; Hugh Bancroft, chairman, Directors of the Port of Boston; W. J. Barney, consulting engineer, New York City; T. M. Robertson, U. S. Department of Commerce, Washington; J. J. Dwyer, president, California State Board of Harbor Commissioners; W. B. Thompson, president, Public Belt Line Commission, New Orleans; Capt. C. O. Sherrill, Corps of Engineers, U. S. A., and B. F. Cresson, Jr., chief engineer, New Jersey Harbor Commission. The publication may be obtained from W. J. Barney, secretary of the association, 29 Broadway, New York City.

TECHNICAL MECHANICS, STATICS AND DYNAMICS. Third Edition. By Edward R. Maurer, Professor of Mechanics in the University of Wisconsin. Cloth, 6 x 9 in.; 356 pages; 438 illustrations; 193 problems. New York, John Wiley & Sons, Inc. $2.50 net.

This edition has been very much improved by practically rewriting the whole book and by the addition of a new set of problems.

The work is divided into two parts—"Statics" and "Dynamics"—covering the customary discussion of subjects ordinarily treated. The text is somewhat verbose, especially when used in connection with a course which is carried on partly by means of lectures. It is, however, very clear if one follows it through, and it should be a great help as a reference.

The problems at the end of the book have been very carefully selected and will give the best of practice in the work of the text.

THE RAILWAY LIBRARY, 1913 (FIFTH SERIES). Compiled and edited by Slason Thompson, Director of Bureau of Railway News and Statistics, Chicago. Cloth, 5½ x 8¼ in.; 469 pages; illustrated. Chicago, R. R. Donnelley & Sons Company. 50 cents.

This is the fifth annual issue of "The Railway Library." Following previous custom, the book brings together noteworthy addresses or papers presented in 1913 on a variety of railroad subjects. In general the topics are the larger aspects of railroading, such as rates, wages, capitalization and government ownership. Touching the engineer's field most closely are "Why Railway Maintenance Costs More," by J. G. Rogers; "Are Increased Train Loads Practicable?" by Charles F. Speare; "The Valuation of Railroads," by Charles A. Prouty; "The Ohio Floods of 1913," by Lewis S. Bigelow; "The World's Greatest Tunnels," by "The Engineer," and "Some Tendencies of the Times," by Prof. George F. Swain. Several of these papers have been abstracted in the Engineering Record.

Among the other authors represented are Theodore Roosevelt, Samuel Rea, Samuel O. Dunn, Prof. W. J. Cunningham, J. O. Fagan, Ralph Peters, Howard Elliott, W. M. Acworth and Maj. Charles Hine. The last 132 pages are devoted to statistics of American railways for the year ended June 30, 1913, compiled by Slason Thompson. At the back of the book are tables of contents of the four previous issues.

A ROAD CENSUS in Iowa, reported in the "Service Bulletin" of the State Highway Commission, gives the total length of public highways outside of incorporated cities and towns as 104,027 mi. The census was taken by the county engineers.

Letters to the Editor

Panama Canal Tolls

SIR: Referring to my communication respecting "Panama Canal Tolls" in your issue of Aug. 1, let me add that Mr. Grunsky, to whom I sent a copy of my communication, calls my attention to a careless arithmetical blunder on my part, making Professor Johnson's suggestion involve our reimbursement for the entire cost of the Canal within ten (instead of 100) years.

It appears also that I had not fully understood Mr. Grunsky's suggestion as to the items to be covered by the tolls which he recommends. If I had received Mr. Grunsky's communication in season I should have omitted the paragraph beginning "Mr. Grunsky urges that the charges for the use of the Canal. . . ."

JOHN C. TRAUTWINE, JR.,
Philadelphia. Civil Engineer.

Confusion in Paving Specifications

SIR: Referring to the letter of Otto H. Klein on the subject of "Confusion in Paving Specifications," based on an editorial which appeared in Engineering Record of June 13:

As I understand the present situation, the methods of testing asphalt flux and asphalt cement were ordered printed in the 1913 "Proceedings" of the Association for Standardizing Paving Specifications. Definite action thereon was, however, postponed until the next meeting of the association, as shown on page 60 of the printed fourth annual report of the association.

It seems to the writer that this condition of affairs tends to give point to your editorial comment as to confusion in paving specifications. In one society the adopted specifications do not agree with the recommended methods of tests.

Philadelphia. D. T. PIERCE.

Large Balanced Valves for Reservoir Outlets

SIR: My attention has been called to your article on balanced valves for reservoir outlet, appearing in your issue of July 11, page 53. The short description given is correct so far as it goes, but is quite incomplete in many features. I hope at some time in the future to prepare an article showing the development of this type of valve, which has proved so successful in our work. There are fourteen valves of this type in operation, the oldest being at Roosevelt.

However, I wish to correct a wrong impression which may be created by your editorial on this article. The situation at Arrowrock referred to in your editorial is as follows: The upper valves become exposed every year and are, therefore, not provided with any external screen. The grid forming the base casting is arranged with the bars only 6 in. apart. This limits the size of a stick of floating timber to that which is easily bitten off by the valve, so that the valve may be opened and closed, even when any amount of material accumulates around it, without injuring the valve.

Valves that are to be left for any length of time submerged should be provided with large screen area. Nevertheless, there are some remarkable examples of how free from débris a valve may remain. The three valves at Roosevelt, after being in use two years, did not have sufficient drift accumulated on them to prevent their operation at maximum capacity, although a large stick had been bitten off by one valve without the knowledge of the operator. I believe all the débris could have been contained within 2 cu. yd. of loosely piled brush, and it was so distributed on the valves as not to interfere with its coefficient of discharge. In one season's discharge, with a rate up to 6000 sec.-ft., extending over several months' time at the Pathfinder dam, the amount of material collected on the screens protecting the six valves could be carried away by one man.

The lower valves at Arrowrock are provided with a separate grillage of large area of 6-in. spacing, and these valves may be unwatered by means of stoplogs and retain 18 ft. of storage above the bottom of the valve while being repaired. No difficulty whatever is expected under these operating conditions at Arrowrock.

O. H. ENSIGN,
Chief Electrical Engineer, U. S. Reclamation Service.
Los Angeles.

How the Ancients Would Have Controlled the Mississippi

SIR: I have been much interested in the paper by Sir William Wilcocks on flood prevention in the Mississippi valley and in the criticism by Mr. Dabney in your issue of July 25, page 115. Both of these gentlemen are evidently thoroughly informed on the problems of river control, and it remains for us merely to accept the best ideas of both that will apply in each case.

One thing about Sir William's article appeals to me particularly as against the ideas of Mr. Dabney. Sir William goes back to the beginning and particularly shows that the Egyptians began to control the lower Nile by working on the upper part of it. Mr. Dabney admits that before dikes can be relied on as a permanent solution of lower Mississippi River troubles the river will have to be cured of its bad habit of gnawing at its banks. Now, what causes a river to gnaw at its banks? In reading a discussion of this subject by members of the American Society of Civil Engineers one comes across frequent mention of rivers that were once orderly open streams with well-defined banks; but which, since the advent of civilization, have become wandering, bank-chewing streams, clogged with bars and generally wider and shallower than they ought to be, and hence more difficult to control. This radical change in many of our American rivers was formerly laid to the destruction of the forests on their banks, but records for one hundred years in this country and for five hundred years in Europe, kept very carefully, fail to disclose any general increase in the severity of floods on account of deforestation.

A feature of my own work has recently brought me into contact with a number of farmers on the south bank of the Missouri River, in the State of Missouri, who have been forced by circumstances to begin at the beginning of river protection and control. Coming on a virgin soil which had never been disturbed by plowing they were astonished and dismayed, and incidentally broken up in business, by having their entire soft surface soil washed away down the small gullies on their property into the Missouri River, leaving them with nothing but bare shale to farm on. They cared nothing for the Missouri River, but in order to prevent the washing away of their farms they adopted a system of dams across their watercourses, each one provided with a string of plain clay sewer pipe under it, the upstream end of the pipe ending in an upturned elbow, on which they erected a standpipe slightly lower than the crest of the dam. The dam thus served to arrest the rushing stream and form a pool out of which the eroded soil soon settled, while the remaining clear water ran down and out through the underdrain pipe. By this simple means they have, in some cases, brought back ruined farms to smoothness and productivity and changed what were formerly gaping gullies into smooth terraced fields.

In the meantime the Missouri River has had just that much less mud to carry away in high water and deposit on some impeding bar at low water, and the United States Government has had that much less to contend with in keeping the river from gnawing its banks in order to make up in width for what these deposits deprived it of in depth.

From seeing the amount of soil that washes into the Missouri River from farmlands when it is not controlled, and the amount that can be saved when it is controlled, it appears to me that the place to begin the control of the Mississippi River is in the small tributary streams rather than near the mouth, for it is obvious to most people that no matter how high and how well we build dikes along the river, these will ultimately be overtopped if the bottom of the river keeps rising year by year.

BENJAMIN BROOKS.
Kansas City, Mo.

Cracking of Drawn Brass

SIR: In your issue of April 11, page 415, there appeared an article by Ernst Jonson, engineer inspector of the New York Board of Water Supply. The subject of this article was "Cracking of Drawn Brass," and the writer received a letter from Mr. Jonson under date of April 14 requesting a contribution to the discussion of the questions raised. I am limited by time to a consideration of the questions involved only as far as they affect the products of the Cramp company, and accordingly will refer in what I have to say below to manganese bronze only.

While Mr. Jonson discusses the matter from an engineering standpoint, I doubt if the questions to which he refers would ever have been raised if considerable financial loss had not been involved in the failure of certain material purchased by the Board of Water Supply. Since the writing of Mr.

Jonson's article further loss of this kind has been sustained and the temper of the engineers of the Board of Water Supply has been strained to a point that makes imminent the condemnation of all manganese bronze. It is only for this reason that I have decided to take up the matter, as such a condemnation would affect not only the imitations of our bronze that have failed, but also our bronze, which has not failed in any particular.

We must first protest against Mr. Jonson assuming as he does in the first paragraph of his article in your paper that his experience with Muntz metal and naval brass allows him to deduce therefrom what will happen to manganese bronze upon the assumption that manganese bronze is simply a slight change in composition from the other two metals. My company has placed in the hands of Mr. Jonson every scrap of information that we have on the matter, has informed him where all our sales have been made in past years, has allowed him to go into our shops and experiment with our bronze to see if it can be destroyed or injured by improper treatment, and to date we are without knowledge of any instance found by him in which a failure of our metal has occurred. In view of this we protest strongly against Mr. Jonson or any other official of the Board of Water Supply generalizing from the behavior of individual so-called manganese bronzes to cover the action or qualities of our bronze. We must also strongly protest against the Board of Water Supply basing any condemnation, public or otherwise, of manganese bronze upon any of the facts so far discovered in connection with imitations of our bronze.

The proper conclusion for the Board of Water Supply to draw after full consideration of all matters in the case is that the trouble has been brought about by unwillingness, or inability, owing to restrictions placed upon the board by law, to pay the right price for what was wanted. It is a well-known fact that nearly all the bronze contracts for the Board of Water Supply have been let for much less than they should have been, owing to excessive competition, that very few contractors, as far as we know, have made little if any profit, and that one well-known contractor has been forced into the hands of receivers, perhaps not entirely by his work for the Board of Water Supply but certainly partly thereby. We know that during the last five or six years he has been quoting for the Board of Water Supply work prices below what the work was worth.

The whole matter is a commercial one pure and simple, and not an engineering proposition. The Board of Water Supply can get what it wants if it is willing to pay for it. If any such misguided action as the substitution of steel for manganese bronze should be made in the water-supply work of New York City the consequences will be felt later.

W. P. SMITH,
Superintendent of Sales, The William Cramp & Sons Ship & Engine Building Company.
Philadelphia.

Expansion of Concrete Sidewalks

SIR: Referring to the article in the Engineering Record of June 27, 1914, page 729, by John Berg, on "Curb Failures at Concrete Crossings," I would like to state that we have had difficulty with expansion of walks. During hot weather occasionally two slabs would buckle upward and would remain in that position, making a bad hump in the walk. Possibly one reason the slabs would not go back into place was on account of sand or dirt of some sort getting into the cracks made when buckling took place. Also there was expansion in the walk for the entire length and the buckling took place at the weakest point. There was a movement in the slabs for some distance each side of the rupture, the amount decreasing according to the distance from the point of rupture. When contraction took place small cracks were formed between slabs and the slabs were not drawn back to the original position. The hump remained in the walk until the slabs were broken down and repaired.

To remedy this we have been putting in a ½-in. expansion joint filled with paving pitch. The joints are placed across the walk at intervals of 36 ft., where new walks abut old walks and where new walks abut curbs. So far they have worked satisfactorily.

C. E. HENDERSON,
Assistant City Engineer.
Port Arthur, Ont.

Incomplete Plans—Their Effect on Bids

SIR: One often sees general plans for buildings which have gone to bidders which are so wofully incomplete that it is impossible for even an experienced man to understand how the contractors were able to do more than guess at the cost of the structure. Some architects and engineers believe it is better to have too little detail work on general plans than too much, on the theory that the contractors' bids will be lower, since they are sure to leave out some items which will eventually have to be furnished. Should these same engineers and architects try the other method, that of getting out more complete plans which leave no doubt in the contractors' minds as to what is desired, they would soon be surprised to find that the contract price represented very nearly the final cost, eliminating the "extras" which are always a source of profit to the contractor and a loss to the owner.

Anyone familiar with the building trades knows that few except the very large general contracting concerns stay in the "game" for any considerable length of time, and looking further it will be found that very few contractors have retired with great, great wealth. They have been forced out by losses due to poor management, etc., but mainly due to poor and incomplete plans, thanks to the architect and engineer who delight in keeping the contractor in the dark while bidding.

Now let us look for a moment at the results of incomplete plans for bidding purposes. In the first place, there is the case of the contractor who gets a job at a very low figure because he forgot to include some items which were required but not clearly shown on the so-called plans. Rather than lose his reputation the contractor probably will complete the work at a loss. In this case the owner profits at the expense of the contractor; but it is safe to say that the latter approaches the same architect or engineer again with a desire to settle the old score and if he succeeds some other owner pays the old debt.

Then, again, a low bid may be obtained from some unscrupulous contractor who does not intend to live up to the meaning and intent of the plans and specifications, relying on their incompleteness as a basis for profitable extras in case the plans are amplified to any degree after the contract is signed. It is only occasionally that the owner profits in the end where such conditions maintain and low bids result.

The owner, then, instead of obtaining a building at a fair price, pays more for it than if the plans had been complete and the bids all made and rendered on a uniform and fair basis. This has been the experience of many owners, and the architect or engineer who caused them to undergo this unpleasant experience has been left out of consideration when further building was done. Thus in the end the architect or engineer is the loser and reaps the benefits of his earlier work. Then, also, contractors soon become aware of the unfair methods adopted by such architects and engineers and as a result they either refuse to enter a bid on future work or add a goodly percentage to cover the cost of work not shown on the plans, which will be demanded for the fulfilment of the usual blanket clause in most specifications, viz., "and all other materials and labor necessary to fully complete the building in accordance with the intent of these plans and specifications."

The present-day tendency is toward the use of more complete plans and specifications for all kinds of work, it having been found that sketch plans do not convey the idea of the architect or engineer to the contractor, and trouble generally results. It is the duty of every engineer and architect to leave nothing to the imagination of the bidders.

Chicago. ALBERT M. WOLF.

Simple Method of Showing Sizes of Pipe Lines

SIR: In your issue of May 23, 1914, page 600, I find an article entitled "Simple Method of Showing Sizes of Pipe Lines." A simpler method than this has been used by the undersigned for some ten years, representing all 6-in. lines by a dash and every additional inch by a point. Thus a 4-in. pipe could be four points; a 6-in., one dash; an 8-in., one dash and two points; a 10-in., a dash and four points; a 12-in., two dashes; a 20-in., three dashes and two points, etc. This can be readily seen at a glance without hardly any mental effort. Of course the dashes and points for each size are close together with a little space left between the adjoining signs. This method has been found very effective and is used in all my designs for work that would require such symbols.

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WIND RECORDS from 1889 to 1913 inclusive, recently summarized in Bulletin 153 of the Massachusetts Agricultural Experiment Station, show that in that time there was a total movement of 1,320,668 mi., a mean daily movement of 145 mi., and a maximum pressure per square foot of 43 lb. due to a wind velocity of 93 mi. per hour on Sept. 11, 1895. On only nine occasions were there recorded gales of 75 mi. per hour or more.